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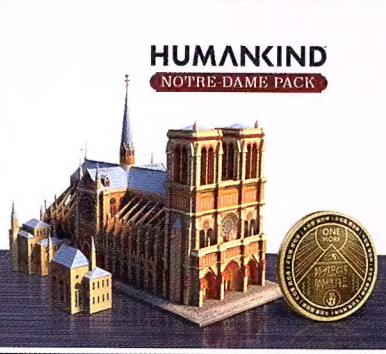

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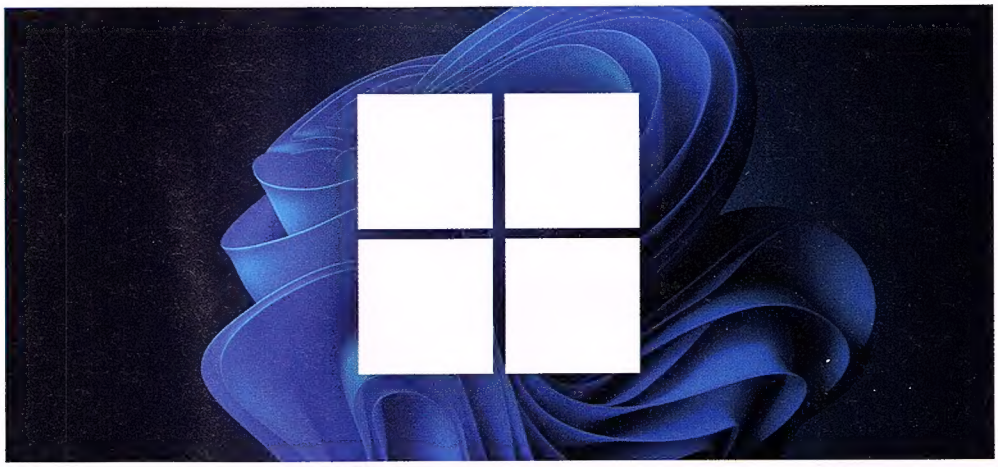
EDITORIAL

THIS ONE GOES TO 11



EDITORIAL

Sharing time

We want your *APC* stories!

500 is a very special number. This is issue #497 of *APC*. Not quite 500 – but *almost*. So you know what that means... it means, friends, that *APC* is about to pass a milestone very few magazines reach, and we're going to mark the occasion properly.

We're celebrating with a retrospective, looking back at the evolution of the PC and PC-tech over the years, and how *APC* was there every step of the way.

But *APC* exists because of you, and your journey through it all is the central story we want to share in issue 500. So! I invite you to take a moment and share your *APC* story, so we can share it with everyone in issue 500.

Send me your tech tales. It could be professional, educational, the fun times, and the moments that made you realise you were hooked. Photos too if you like. Whether you're new to *APC* or have been with us for many years – let's celebrate the last four-and-a-bit decades together.

How does *APC* intersect with your PC life? Perhaps there was a story we ran that sparked something in you to take it a step further. Has your PC career seen *APC* alongside you, as you discover new PC tech as it comes, and as you became an expert? Was it a single review of something we looked at that got you excited? Perhaps you bought the product, and perhaps it was the beginning of a long journey down the rabbit hole.

We'll print the best tales and snippets in issue 500. I don't think we'll be able to fit gigantic-long tales, but we'll endeavour to include as much from you as possible – and yes please do include a photo – extra points if you manage to include some *APC* in there too!

We want to do a great job of issue 500 – so get in touch, I'm at **ben.mansill@futurenet.com**, and I can't wait to read about you, your love for the PC and how *APC* has been there in your life.

Really, though, we're just using this issue 500 as a practise run, so we're all skilled up at making high quality anniversary issues, so that when *APC* #1,000 rolls around we'll totally ace it. Onwards!

BEN MANSILL

2021 AUSTRALIAN PC AWARDS COMPETITION WINNERS:

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EPISODE 2 **1st prize:** Gigabyte AERO 15 XC laptop worth AU$3,099 - D Kick, VIC **2nd prize:** MSI CH130X Gaming Chair worth AU$399 + MSI Sekira 100R Case worth AU$219 + MSI Vigor GK50 Elite Keyboard worth AU$119 + MSI GM41 Wireless Gaming Mouse worth AU$78 - S Ryder, NSW **3rd prize:** Aten UC3022 CamLive Pro Dual HDMI to USB-C UVC Video Capture worth AU$679 - R Woods, NSW

EPISODE 3 **1st prize:** Gigabyte AERO 17 KC laptop worth AU$2,999 - W Ly, ACT **2nd prize:** Thermaltake Citadel Gaming System PC worth AU$2,399 - K Randall-Demllo, VIC **3rd prize:** Corsair K70 TKL keyboard worth AU$299 + Corsair Sabre Pro RGB mouse worth AU$99 - N Verplak, VIC

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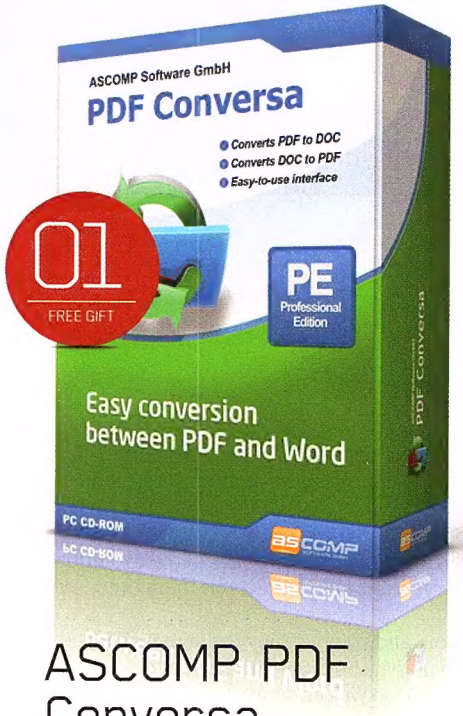

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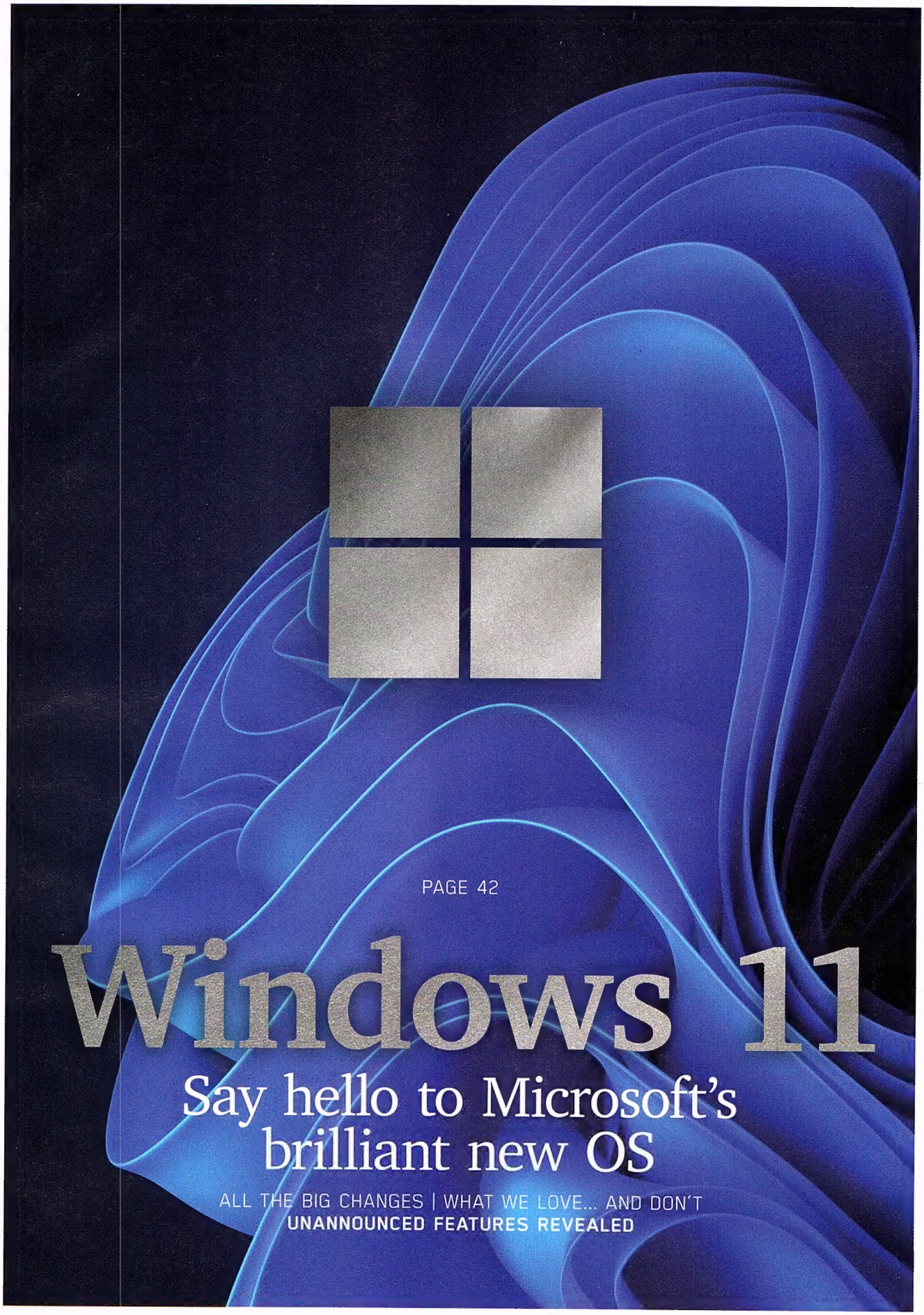

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Say hello to Microsoft's brilliant new OS

ALL THE BIG CHANGES | WHAT WE LOVE... AND DON'T
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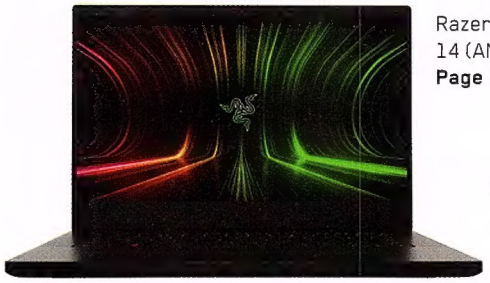

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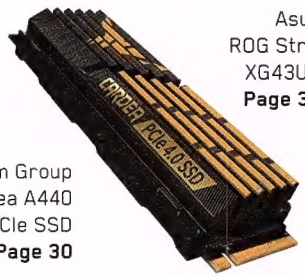

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You will see this award if a reviewed product has scored four out of five stars. It means most people can expect satisfying performance from the product, and that we would use it ourselves.

Inside *APC*

Find out all about *APC*'s editorial policies, test practices, how to read the benchmark results, and more.

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, *APC*'s journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and *APC* aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in *APC* are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an *APC* reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

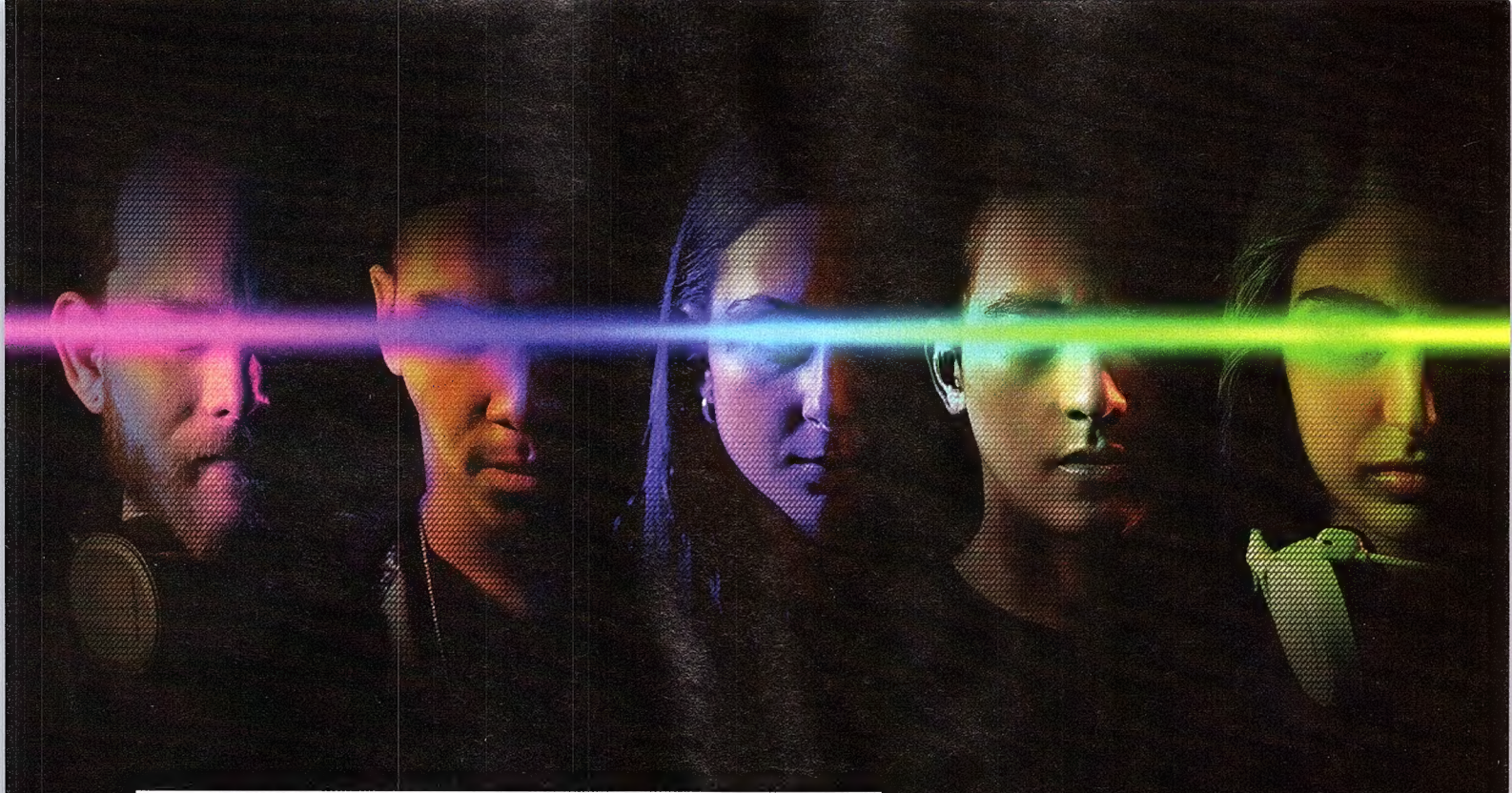
In most cases, for the benchmark results published in *APC*, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred. ■

APC testbed

The current *APC* testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	MSI GeForce RTX 3080 Gaming X Trio
Memory	2x8GB Team T-Force Xtreem ARGB DDR4-3600
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000



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TECHNOTES

ALL THE NEED-TO-KNOW TECH NEWS

Windows 10 will support game-boosting DirectStorage after all

But Windows 11 will have superior performance.

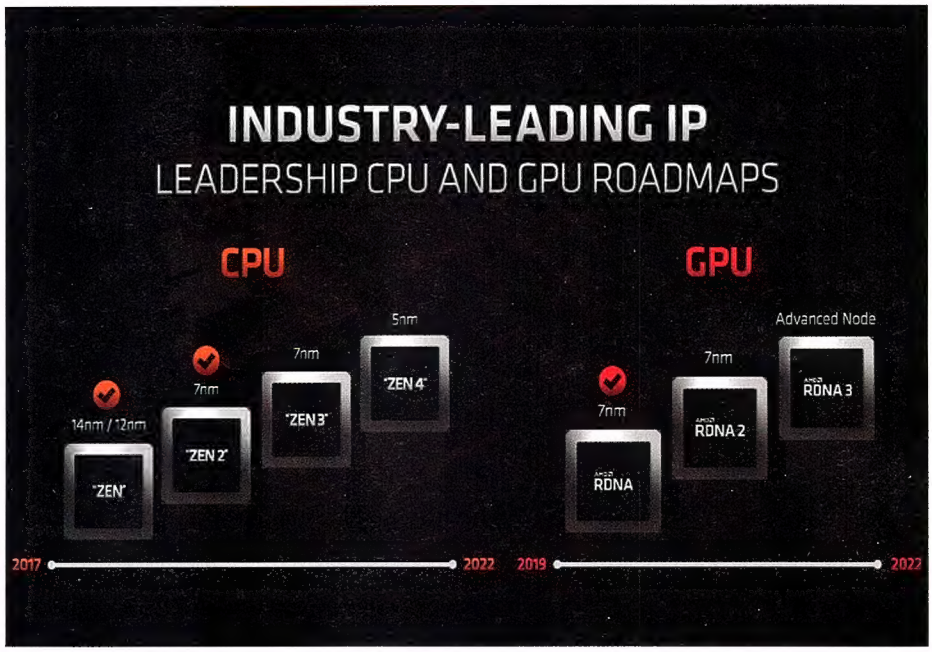
A recent Microsoft blog post has corrected the company's earlier statement that DirectStorage, a tech that boosts storage performance to improve gaming, would only be available in Windows 11. Now Microsoft has clarified that DirectStorage will indeed support both Windows 10 and Windows 11.

DirectStorage is a new storage acceleration API, currently used in Xbox Series consoles, that improves game loading times by allowing game data to be transferred directly from an NVMe SSD to the GPU, thus bypassing the CPU. To further speed up performance, DirectStorage also includes a new GPU decompression technology that supports higher decompression I/O rates and bandwidth than CPUs. That also makes the GPU a better option to decompress game assets.

RTX 3090 cards dying in Amazon's *New World* beta

A confounding, unexplained issue is sending EVGA cards to an early RMA graveyard.

RTX 3090 graphics cards apparently dying while playing a video game isn't the *New World* Amazon envisioned when it opened up the beta for its upcoming game. A growing number of Reddit users are claiming that their EVGA RTX 3090 cards are dying when playing the game. From the current number of reports it seems that for now only EVGA RTX 3090 cards are affected (there is not a single reference to an AMD card being affected), but other users are reporting mysterious 100 percent loads in the main menu or loading screens, with other brands and RTX 30-series models. It appears that capping the framerates may prevent this from happening, which points towards the cards simply pulling too much power for their own circuitry.



Pic: AMD

CPU NEWS

AMD's Zen 4 Raphael CPUs will likely max out at 16 cores

More than enough.

There's a lot to be excited about with AMD's Zen 4 microarchitecture. For starters, the chips are rumoured to come with TSMC's leading-edge 5nm process node. Previously, there were strong rumours that AMD could add a third chiplet to Ryzen 6000 to bump the core count up to 24, but reputable leaker ExecutableFix has dispelled that rumour. However, it was probably wishful thinking from the start since AMD already offers more cores than Intel on a mainstream processor. Furthermore, it wouldn't make sense for AMD to continue adding more cores since it would only threaten the chipmaker's Ryzen Threadripper HEDT lineup.

Barring any surprises, the Ryzen 9 6950X will likely be the flagship chip for the Ryzen 6000 series. Logically, the 16-core part will replace the existing Ryzen 9 5950X. Although we might not see more cores, Zen 4 will allegedly offer us other advances in exchange, such as DDR5 support and four additional PCIe 4.0 lanes for more connectivity. In terms of TDP, Zen 4 isn't expected to be a lot more power-demanding than Zen 3.

AMD has retained the AM4 socket for a while now, so the chipmaker will, in all probability, transition to the AM5 socket going forward. ExecutableFix has already provided us a mockup of how Zen 4 could look. Besides the stylish IHS (integrated heat spreader), the processor reportedly will no longer have any pins since the AM5 socket is rumoured to sport a Land Grid Array (LGA) design, similar to what Intel has done since LGA775. However, the new layout doesn't look awfully different, so there's a chance that existing AM4 cooling solutions can work on AM5 with a converter kit.

AMD is in no hurry to get Zen 4 out. The company's Ryzen 5000 (codename Vermeer) chips, which are based on Zen 3 cores, are among the best CPUs on the market right now. Furthermore, the chipmaker recently revealed a new Zen 3 Ryzen processor with 3D V-Cache that can deliver up to 192MB of L3 cache per chip. As a result, AMD has enough assets to hold Intel off until Zen 4, which may not debut until the fourth quarter of 2022.

"Barring any surprises, the Ryzen 9 6950X will likely be the flagship chip for the Ryzen 6000 series. Logically, the 16-core part will replace the existing Ryzen 9 5950X."

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Pic: Atom Computing

100-qubit quantum computing system unveiled

Startup reveals a unique quantum computing system.

Atom Computing, a quantum computing startup, has announced a quantum computing system with unparalleled capabilities. The company's first-generation Phoenix system can pack as many as 100 qubits that are said to be 'exceptionally' stable with long coherence times, thus providing extreme performance potential. Separately, the company announced that it had secured over $20 million in Series A funding and hired a new CEO.

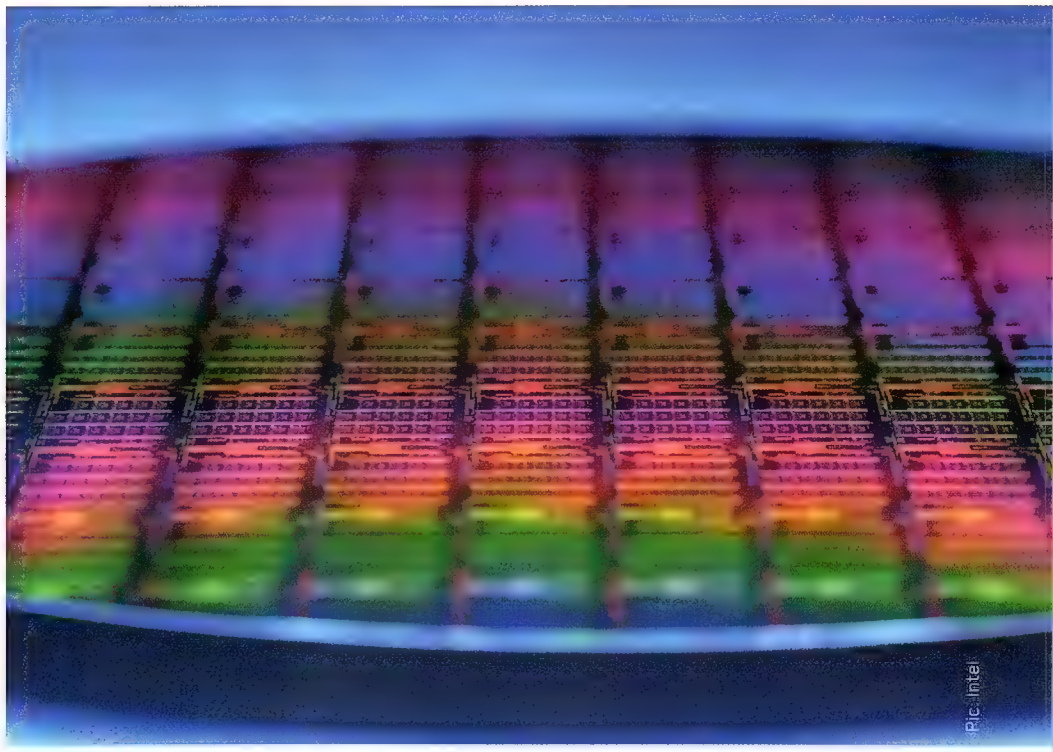
Atom Computing's Phoenix can trap 100 atomic qubits (of an alkaline earth element) in a vacuum chamber with optical tweezers. Then, the quantum states of atomic qubits are manipulated with lasers. The company claims that its qubits are remarkably stable and have very long coherence times (i.e., over 100 ms), making Atom Computing's Phoenix suitable for complex computations.

Reddit opens Australian office

Upvotes the land down under.

Reddit is as popular here as it is in most countries, with Australia ranking fourth overall in the global Reddit user base. Now the company has opened up a local office, which will be staffed with community, engineering and sales staff, and will be headed up by Country Manager David Ray.

"We've been fortunate to experience strong organic growth from our Australian user base in recent years, and with this comes a significant opportunity to level-up our local offering in a more focussed and nuanced way," said Reddit Chief Operating officer, Jen Wong. "From building out our highly engaged Australian communities to finding homes for local brands on the platform, this launch is just the beginning of our investment in the market."



Pic: Intel

FAB NEWS

Intel in talks to buy GlobalFoundries for US$30 billion

Buying its way in.

According to a report from the *Wall Street Journal* citing people familiar with the matter, Intel is in talks to buy GlobalFoundries for roughly US$30 billion. Intel has not confirmed the report, but if true, the plan would intercept GlobalFoundries' widely-reported plans for an IPO later this year.

The news comes on the heels of recent reports that Intel is in talks to buy RISC-V chip designer SiFive for US$2 billion as it undergoes a major restructuring effort under new CEO Pat Gelsinger.

Intel's rumoured buy-out plan also comes as it lobbies the US government for subsidies to boost its manufacturing capabilities, particularly to help fund its IDM 2.0 initiative that will find it producing chips for other companies through a newly-formed Intel Foundry Services (IFS).

Acquiring GlobalFoundries would be an immediate shot in the arm for that initiative, particularly because it would bring in experienced leadership teams and an already-healthy third-party foundry business.

GlobalFoundries' production capacity of trailing-edge nodes, which are the largest volume movers for most third-party fabs, would also fit well with Intel's plans to begin offering its manufacturing services to other parties.

Now there's a nuclear-powered crypto mining facility

That's a whole lot of bitcoin that is going to be mined.

A report from *Data Center Dynamics* says Talen Energy, a US power company, plans on building a 300MW crypto mining facility and data centre next to its nuclear Susquehanna Steam Electric Station in Pennsylvania.

The business responsible for the crypto mining operation, Cumulus Coin, is a subsidiary of Talen Energy and expects the project to come online in the spring of 2022, with the first phase of development having 164MW of capacity. The goal is to have at least 300MW of onsite power by completion and the ability to expand to 1GW capacity in the future.

Just to give you an idea of how lucrative these crypto mining operations are, the Albany Engineering Corp in New York said they could make more money mining cryptocurrency at its nearly 200-year-old hydroelectric power plant than providing power to customers on its entire energy grid. ■

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TECH BRIEF

TSMC exploring on-chip integrated watercooling

Future chips may feature watercooling integrated into the silicon.

TSMC, at the VLSI symposium, recently presented its investigations into on-chip watercooling as a way to battle issues with heat dissipation. And it involves integrating water channels straight into the chip's design.

As transistors get increasingly compressed together due to denser manufacturing technologies and added vertical 3D chip stacking, temperature becomes an increasingly critical problem to address. TSMC's researchers think the solution is allowing water to flow in-between sandwiched circuits. It's an incredibly simple theoretical solution, but is an extremely difficult engineering feat to pull off safely – for the electronics, that is.

The mathematics are simple: Current cooling solutions typically work via direct contact with a given chip's heatspreader, direct die contact technologies, or full submersion in a non-conducting fluid. Of these, the first two solutions can only efficiently cool the layers they're directly in contact with, which brings huge problems for vertical chip stacking. The lower layers will have much more trouble dissipating their heat, with of damage or having to throttle, either of which would be bad for performance.

Not only that, but the top layer of the chip will have added strain from having to essentially carry the entire package's heat through to the dissipation layer. And liquid submersion, while efficient and likely better for stacked dies, is expensive and difficult to deploy in professional scenarios that are already geared for air or traditional water cooling.

TSMC carried out testing on a dummy semicondutor – a Thermal Test Vehicle (TTV), which is essentially a heating element made out of copper – in controlled lab conditions. The company tested three types of silicon water channel integration in controlled conditions: It used a pillar-based channel, where water could flow around active semiconductor pillars to cool them down (think of water around an island); a design which featured a trench design (think of a river, controlled by its shores); and a simple, flat water channel on top of the rest of the silicon chip. The water was passed through an external cooling mechanism that chilled the water down to 25 °C from its journey through the silicon chips.

The company further tested three types of water cooling designs: one with only direct water cooling (DWC), where water has its own circulating channels etched directly into the chip's silicon as part of the manufacturing process; another design with water channels being etched into their own silicon layer on top of the chip proper, with a Thermal Interface Material (TIM) layer of OX (Silicon Oxide Fusion) that carried heat from the chip to the watercooling layer; and lastly a design which swapped the OX layer for a simpler, cheaper liquid metal solution.

TSMC reported that the best solution was by far the direct water cooling method, which could dissipate up to 2.6 kW of heat and offered a temperature delta of 63 °C. The second-best design was naturally the OX TIM-based one, which could still dissipate up to 2.3 kW of heat and offered a temperature delta of 83 °C. The liquid metal solution came in last, still managing to dissipate up to 1.8 kW (temperature delta of 75 ° C). Of all the water flow designs, the pillar-based one was the best by far.

FRANCISCO PIRES ■

"As transistors get increasingly compressed together due to denser manufacturing technologies and added vertical 3D chip stacking, temperature becomes an increasingly critical problem to address."

Pic: Shutterstock

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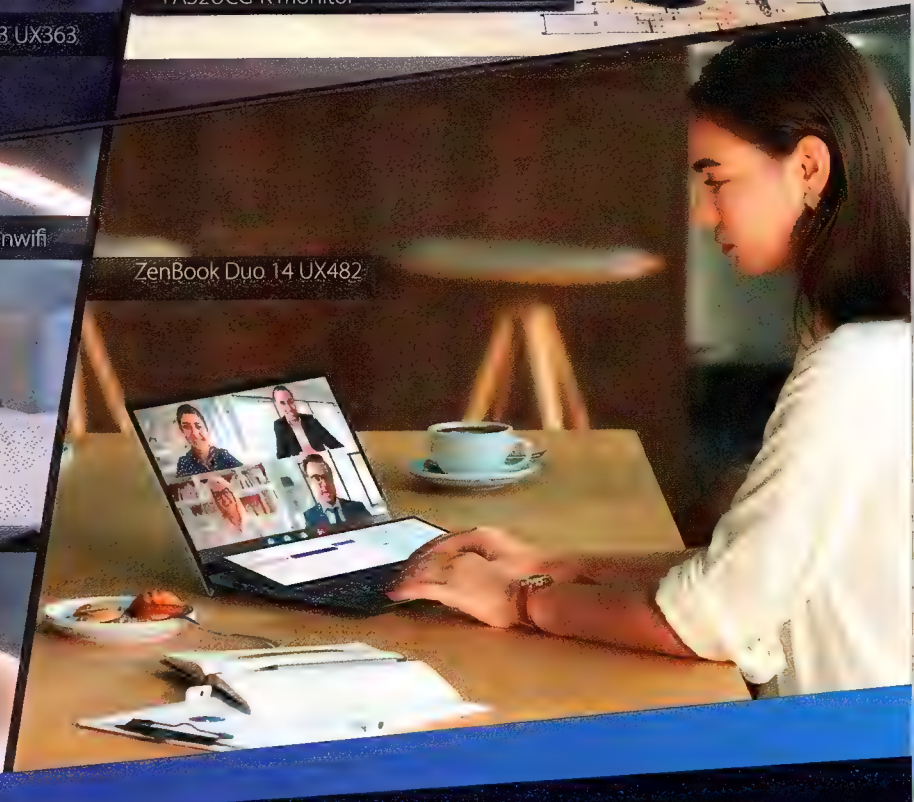

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END USER

Steam Deck is more than just the Valve Switch

This is Valve's second attempt to take over our living rooms, this time by stealth, writes Shaun Prescott.

Last month Valve unveiled its long-rumoured Steam Deck, a powerful handheld gaming console capable of playing pretty much everything in your Steam library. Bearing a strong resemblance to the Nintendo Switch, the announcement came only a week after the latter company unveiled its Switch OLED model which, despite having a bigger and prettier display, did nothing to improve on the console's extremely long-in-the-tooth specs.

The Steam Deck looks a lot like the Switch, but it'd be silly to write it off as simply a competitor in the handheld gaming space. No, this is Valve's gaming console; basically the return of the Steam Machine. It'll load straight into the Linux-based, Proton-powered Steam Deck UI, and once your Steam account is linked you'll be ready to go. Not only that, but it supports pretty much every Bluetooth or USB-C peripheral, so you can plug it into a TV or monitor, pair an Xbox controller, and it essentially is a home console (a Switch style dock is also being sold separately).

No one could make the claim that PC gaming is niche, but the console market is still strong – despite regular claims that it's dying – for a reason. A lot of people don't want to have to upgrade their GPU every three or so years. Also, what's memory? Arguably one of the problems with Steam Machines was that the specs varied wildly, and the upgrade capabilities scared people who just wanted a console that would boot whatever they could throw at it. But no such confusion exists with the Deck: all three models have the same specs, save different storage capacity. There's nothing stopping you from unlocking it, installing Windows 10, and using it as a PC. Heck, you can install Epic Games Store's client on it.

This isn't a competitor to the Series X or PS5, if the measure of competition is horsepower, but it's a clear demonstration that Valve wants your living room – not just your commute. Once the Steam Deck has released, Valve is replacing Steam's Big Picture mode with the Steam Deck UI, meaning that if you want to make your own living room console based around the Deck's console-centric user interface, there's nothing stopping you. Maybe one day we'll see Valve return to making its own living room consoles, only this time with a better idea of what people want.

The Steam Deck is also a clear demonstration that Valve cares about evolving the PC as a gaming platform. Sure, it makes millions taking a cut from every Steam sale, but no matter how much money Epic Games throws at studios and publishers for store exclusives, it'll never topple Steam unless it actually makes PC gaming better. And anyway, if the Steam Deck takes off like the Switch did, even by half, what developer will want their game to be absent from the Steam Deck store?

The elephant in the room, for us at least, is that Steam Deck won't ship to Australia until at the soonest 2022. It took two years for Valve to start selling its Index VR kit via EB Games locally, and if history is any indication, the company isn't too fussed if Australians miss out for a while. This attitude could throw a spanner in the works, as will the supply shortages hitting just about every area of consumer tech in 2021. Whatever the case, if the Steam Deck catches on, it's good news for Valve and us. ■

SHAUN PRESCOTT
Author, PC Gamer editor and passionate technology observer, Shaun covers trending tech topics for *APC*.

"A lot of people don't want to have to upgrade their GPU every three or so years. Also, what's memory?"

The ugly truth about Facebook

Did Zuckerberg just sunset any hope of dismantling his giant Frankenstein social media enterprise?

Everyone was making fun of Mark Zuckerberg online for the ridiculous video he posted of himself riding a hydrofoil at sunset to 'Take Me Home, Country Road' while waving an American flag on the 4th of July. And for good reason. The caricature that seems stranger than fiction is perhaps the perfect example of the unregulated modern Wild West that the technology sector enjoys in the USA currently.

But while everyone was laughing at him, Zuckerberg was laughing right back at the country that had just let his company off the hook the week before, for a serious antitrust case brought forward by the Federal Trade Commission. The now rejected lawsuit threatened to break Facebook up into its major constituent parts (WhatsApp and Instagram) arguing that the company's monopoly on social media had allowed it to run anticompetitive campaigns to stifle any competition in the space.

While the recent FTC filing wasn't able to make its argument for Facebook's illegal business practices stick just yet, a new book by *New York Times* reporters Sheera Frenkel and Cecilia Kang, *An Ugly Truth: Inside Facebook's Battle for Domination,* manages to at least shed some light on the company's leadership incompetencies. The book's general thrust suggests that through a combination of ignorance, ineptitude, and at times intentional immoral stances held by executives, the company rode its uncontrollable social media monster through a number of crises from 2016 to 2020, in a way that ensured profits were put ahead of moral considerations.

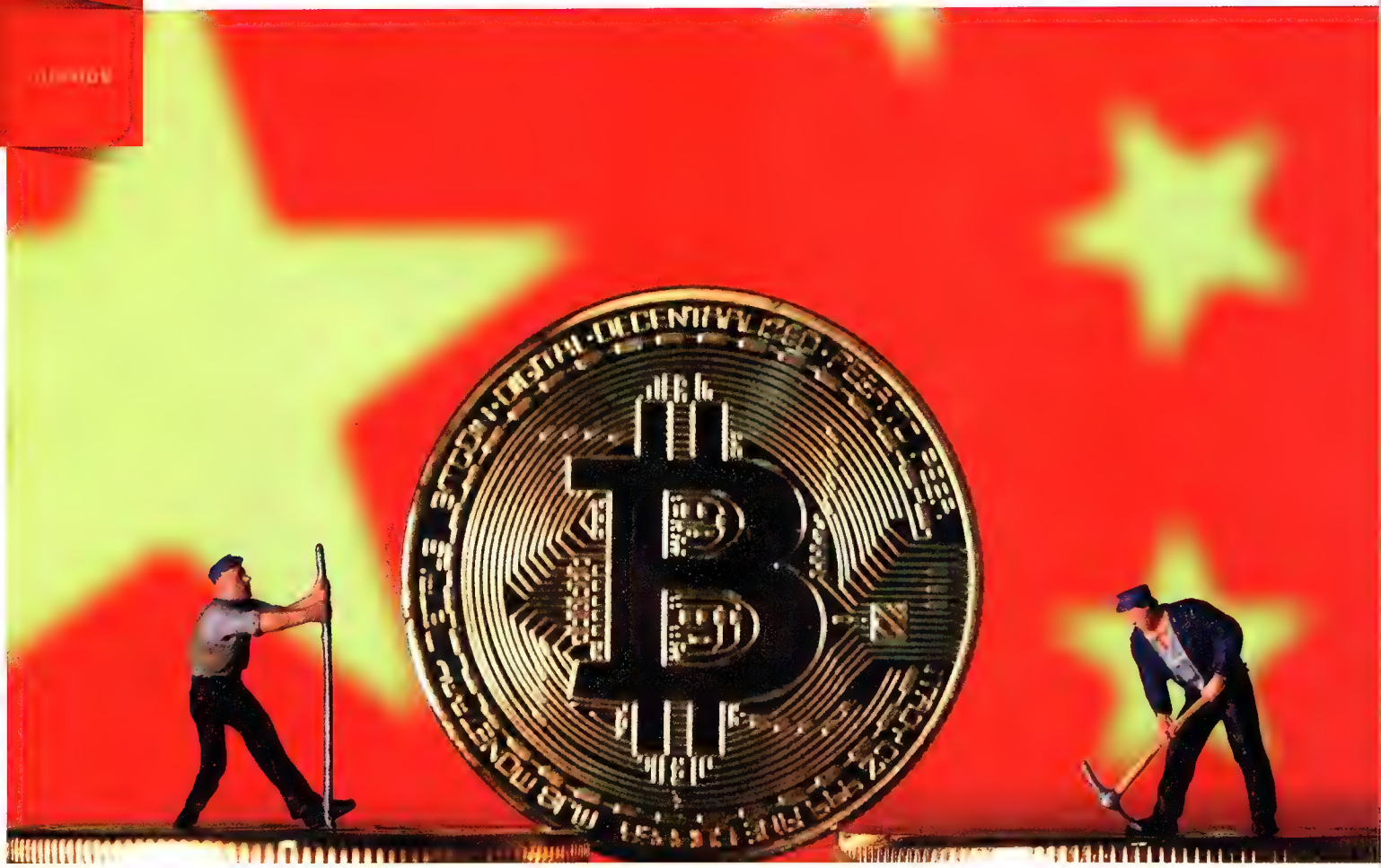
According to the book, when employees responded to the increasing presence of manifestly fake news sites being permitted to circulate under the Facebook terms of service in 2016, a memo from early executive Andrew "Boz" Bosworth suggested that the 'ugly truth' was that even if by connecting people Facebook was facilitating harm, the company had no intention of stopping. The book also claims that Zuckerberg's mantra for employees was "company over country", a motto that distills the numerous occasions that demonstrate the company's propensity to put profits ahead of the plight of people in any circumstance where they came into conflict.

An Ugly Truth also illuminates the role of Joel Kaplan, the head of Facebook's lobbying arm during the tumultuous Trump period and close friend of Justice Brett Kavanaugh. In addition to supporting the Judge (on Facebook's time) during the rape allegations heard at his Supreme Court appointment hearings, Kaplan also seemed to be a competent backchannel operator, influencing decisions both in Washington D.C.and at Facebook HQ in Silicon Valley. The book suggests that the Republican was the driving force behind decisions like the one to permit Trump's post calling for a Muslim ban in 2015 ahead of the election. Kaplan was also instrumental in pushing the argument for keeping a fake video of Nancy Pelosi on the site in 2020, downplaying the role of Russian interference in the 2016 presidential election, killing a 'Trending News' section that was opposed by conservative politicians, arguing Trump's bleach recommendation for Covid 19 treatment wasn't medical advice so could remain on the site, and defending Trump's response to the George Floyd Protests of "When the looting starts, the shooting starts". Clearly Trump was good for business according to Facebook.

So while Zuckerberg's Independence Day stunt may be construed as a love of America, a more nuanced interpretation is that he loves the place that allows him to put his company's interests ahead of any moral duty to his countrymen. Company over country! ■

JOEL BURGESS
When not reviewing PCs for *APC* and writing our funny pages, Joel likes to ponder tech and how it's used.

Pic: Mike Winkelmann



TWO BITS

3D stacking: GPU prices are falling

It's about damn time.

Is it actually possible? Can you actually go to a PC website and see a current generation graphics card in stock? At the time of writing, popular cards such as the RTX 3080 and RX 6700 XT were in stock at several large retailers. It's something that's been very rare over the whole of 2021. Though there's some way to go before prices return to RRP levels, there are many reasons to be optimistic. It's possible we may even see something resembling a crash, with price competition and oversupply in the back end of 2021.

There are several reasons for gamers to be optimistic. The Chinese mining crackdown along with lower crypto prices, the release of Nvidia's low hash rate cards, increased production and a softening of the PC market as a whole are all pointing to a reset of the market.

The Chinese mining industry and its ravenous appetite for more GPUs ate up far too much global supply. The Chinese government cited environmental concerns and things like criminality as reason for the crackdown, but it's also obvious that decentralised crypto currencies are antithetical to a centralised government. Higher average power costs in other countries combined with the high costs of graphics cards makes it harder for miners to recoup on their investments, leading to lower demand. Add to this the precipitous drop in the prices of popular proof-of-work crypto currencies, and it makes it even harder for miners to stay in profit. All of this means that more graphics cards are making their way into the hands of... gamers!

Big corporations are not usually known for their altruism, so Nvidia does deserve credit for producing artificially limited, low hash rate (LHR) cards, which are less appealing to miners. It remains to be seen if there's any possible workaround this block, but for now it seems to be holding.

Supplies are increasing. You can't just flick a switch and make more cards. It takes months to go from chip fabrication to AIB assembly to packing and shipping to on-shelf. There's no doubt that both Nvidia and AMD sought to increase production during the first half of the year.

It's around 18 months since the start of the pandemic. In that time, we've mostly learned to adjust to the challenges it presents. Those who can work from home or had more leisure time have mostly already bought new systems or upgraded. Some analysts predict that the PC market is showing early signs of a slowdown, at least it is from the explosive growth it was experiencing in recent quarters. Spending is being allocated elsewhere and this means more systems and components are available to purchase.

There are further signs of a possible correction. Scalpers selling on Ebay are seeing their ridiculously priced cards unsold, plus there are many auctions for batches of cards. All those millions of mining cards will end up on the second-hand market sooner or later. Expectations of lower prices in the future will accelerate the process.

Add all of these things together and we might not just be looking at a return to normalcy, but the possibility of oversupply. The second half of 2021 might present some great GPU buying opportunities. ■

CHRIS SZEWCZYK
A life-long PC tech enthusiast, Chris has worked acoss the industry in many areas as a product and technology expert.

Pic: SCMP

Free performance

A DLSS competitor that works on any GPU.

For three years, we've been talking about Nvidia's DLSS tech – Deep Learning Super Sampling. The original DLSS 1.0 was a bit lacking, as it was limited in what it could do and required per-game training on Nvidia's supercomputer. DLSS 2.0 changed the underlying algorithm and made it easier to use, with better results. Now AMD has created a competitor: FSR.

The core concept of FSR (FidelityFX Super Resolution) is something we've seen many times. It will use a spatial upscaling algorithm so that games can render at a lower resolution, thus boosting frame rates. While there will undoubtedly be some loss in visual fidelity, the more pertinent question is whether gamers will notice or care.

We've seen upscaling algorithms since the first Blu-ray players arrived in 2006, attempting to improve the experience of watching lower-resolution DVDs (720x480) by scaling to 720p or 1080p. TVs and Blu-ray players can now upscale 1080p content to 4K or 8K, and the results range from OK to quite good. Hopefully, FSR lands on the higher end of that spectrum, but more importantly, it should provide a major boost to performance.

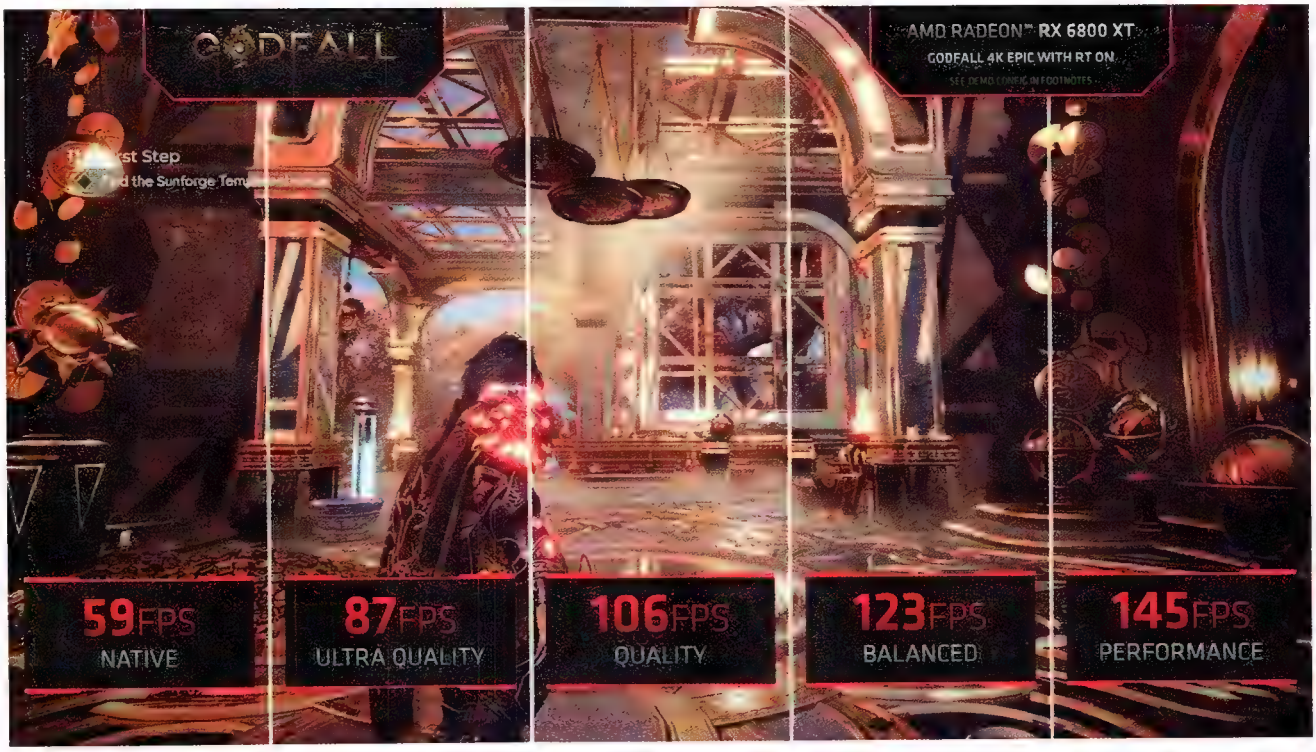
FSR will support four upscaling modes: ultra quality, quality, balanced, and performance. Game developers can also implement dynamic upscaling, where the algorithm isn't linked to a static resolution. Right now, AMD uses scaling factors of 1.3x, 1.5x, 1.7x, and 2.0x – in each dimension – so ultra quality, as an example, will scale 2,594x1,662 content up to 4K, or 1,970x1,108 content up to 1440p. The performance mode, meanwhile, renders a quarter as many pixels, the same factor that Nvidia's DLSS 2.0 uses in its performance mode.

There are plenty of differences between FSR and DLSS. DLSS 2.0 uses a temporal upscaling algorithm combined with a machine-learning trained network that attempts to upscale and remove jaggies. This network runs on the tensor cores in RTX cards, so it can only run on Nvidia's RTX hardware. Temporal upscaling uses the output of current and previous frames to try to optimise quality, and the end results have been impressive. DLSS 1.0 used spatial upscaling, which uses only the data from a single frame, with less-than-ideal results. FSR will hopefully manage to do spatial upscaling better than DLSS 1.0.

JARRED WALTON
Jarred Walton has been a PC and gaming enthusiast for over 30 years.

The bigger difference is AMD's open approach to FidelityFX, as the code and implementation details are part of the GPUOpen library of effects. AMD has already released contrast aware sharpening (CAS), variable rate shading (VRS), ambient occlusion, denoiser, and other effects under the FidelityFX umbrella, and there are more than 45 games that make use of one or more FidelityFX libraries. Perhaps the biggest benefit is that FidelityFX libraries are hardware agnostic, and can run on current and previous-gen AMD and Nvidia hardware, and even Intel GPUs.

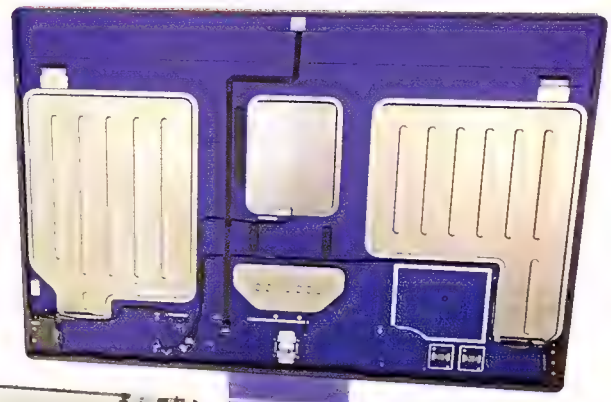
AMD's data shows a 40 percent improvement in performance using ultra quality, and around 2.5x improvement in performance mode. And that wasn't just on the latest GPUs; FSR could mean a new lease on life for older cards. ■

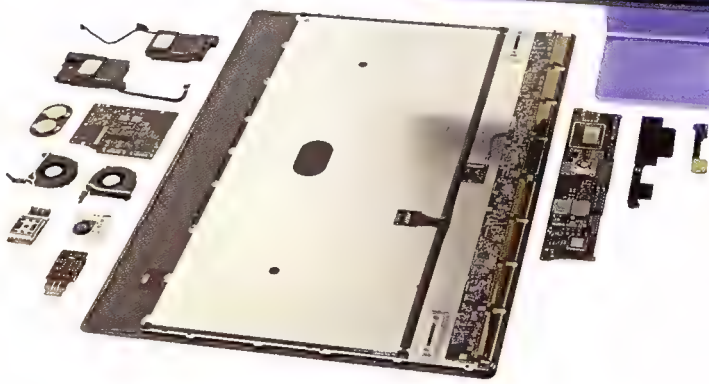


FSR promises large gains in performance via image upscaling, with four settings balancing quality against performance.

iMac M1 24in

You can have this teardown in any colour you want, so long as it's purple.





Is the new M1 iMac just a silly-sized M1 iPad, a detached-keyboard M1 MacBook, or an M1 Mac Mini stretched out like pizza dough? We'll only know by getting inside, however tough that might be. It's time for a teardown of the mid-tier model.

Major tech specs

- Apple M1 chip with eight-core CPU (four performance cores and four efficiency cores) and 16-core Neural Engine
- Apple M1 integrated GPU
- 8GB of unified memory
- 23.5-inch (diagonal) True Tone display with 4480×2520 resolution and support for one billion colors (P3 colour gamut)
- 256GB of SSD storage

Key findings

- Specs aside, at first glance this iMac looks like an iPad on a stand. We've been doing iMac teardowns for a long time, so we're fairly quick by now, but if you're impatient, nothing beats an X-ray. Compared to an X-ray of the 27-inch Intel iMac, we noticed a few things. The new iMac's interior is dominated by two huge metal plates. What are those for? The Apple logo provides a convenient RF pass-through for antenna hardware. Almost all the silicon is concentrated into narrow horizontal strips at the top (display board) and bottom (main logic board).
- Our mid-range unit comes with two Thunderbolt 4 ports and two regular USB-C ports. That's double the base model, but not much for a desktop. The M1 iMac is two iPads thin – not deep enough for a headphone jack, so it turns its jack sideways to fit.
- The M1 iMac still uses adhesive, so it's not quite the goopy iPad nightmare that we feared. It's not all familiar, though. This M1 is actively cooled by a pair of fans, the first M1 iMac to feature more than one. Each fan blows inward across the logic board, where the heatsink draws heat away from the M1 with a copper heat pipe and two short heatsinks.
- If you guessed that those shiny metal chambers were part of the speaker system, you were right. They're impossibly thin (about 1.5mm at the opening), but their sprawling surface area equates to a large volume, thus more air and fuller sound.
- What else can we shake out of this iMacPad? First we find a modular headphone jack – good news, considering this could be the port that sees the most action. The chassis's thinness does have a silver lining: The headphone jack isn't on the back. There is a power button, too, on a sturdy metal bracket, which is glued to the enclosure. It actuates on a little hinge. Also found is a "studio-quality" triple-microphone array.
- The display shield features two horizontal slots that hang on corresponding tabs in the case, keeping the display securely mounted. The stand's hinge hardware is no longer accessible from outside, so choose VESA. The newest iMac follows other M1 machines down an interesting but even-less-repairable path. A lot of impressive engineering went into making it as thin as possible, but did anyone need a thinner all-in-one desktop?
- Repairability Score: 2 out of 10 (10 is easiest to repair). The fans, USB ports, headphone jack, power button, speakers, and webcam are all reasonably modular and fixable in a pinch. The external power supply is trivial to replace, but very difficult to service. The display is tedious to remove and replace, but is the most accessible component. There's no altering the internal storage at all. Memory is soldered to the M1 package, making it impractical to replace or upgrade. The only path of entry is through the display adhesive, making all repairs tedious. ■

Below Left: Like past iMacs, the logo has a cutout that acts as a convenient window for a patch antenna.
Below Right: Quirky, colourful, and bold – we like it, Apple.

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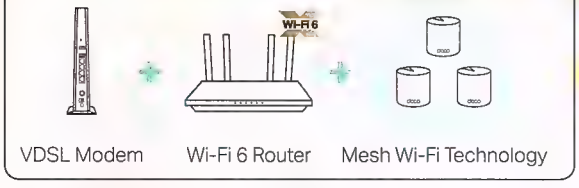

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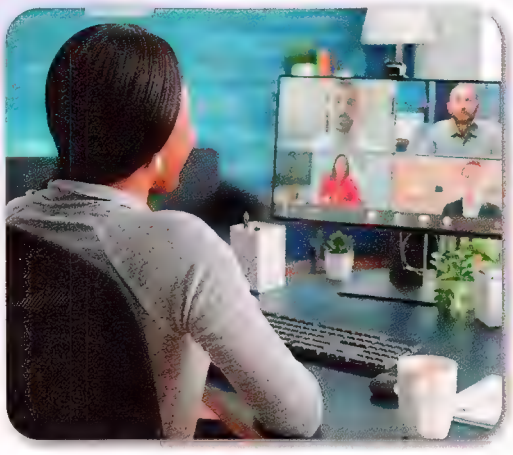

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GADGETS

TECHY TOYS THAT MAY OR MAY NOT INSPIRE JOY

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Evolve Hadean

The most powerful e-board can now tackle any urban hill.

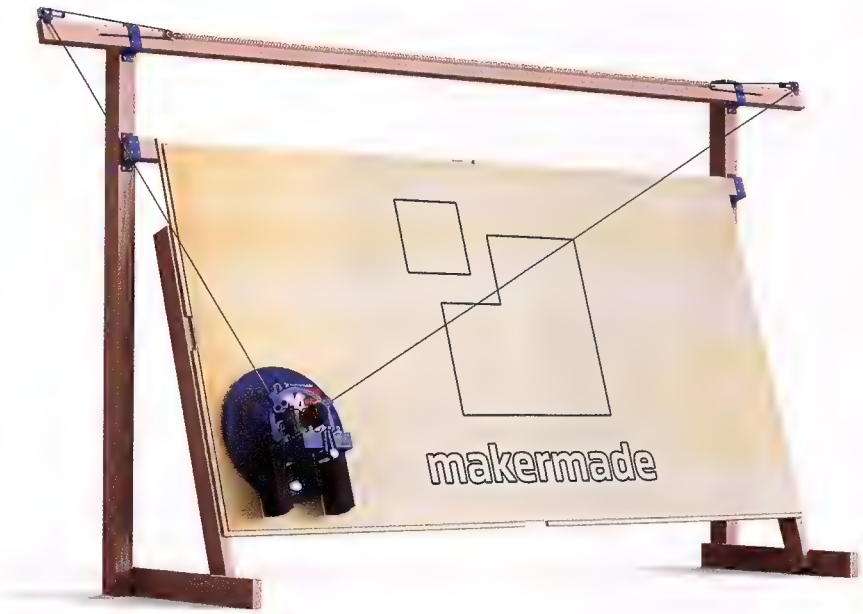
Long standing electric skateboard manufacturer Evolve has a new crown jewel in its lineup called the Hadean. Boasting a new top speed of 42-50km/h depending on the All Terrain or Street model and a respective 40-65km range, these boards are a big step up from their GTR predecessors in both ways. This is thanks to a doubling of the motor power and a massive 691Wh battery that is able to push you up the world's steepest roads... literally.

US$479 | kck.st/3vNX9x8

Reinkstone

A powerful colour e-paper tablet that'll kill eye strain.

This new Kickstarter is a colour paper tablet that utilises a new 140ppi e-ink screen for higher resolution paper-like display on a modern versatile device. The 10.1-inch 2,232 x 1,680 pixel display is notably more vibrant than predecessors and the device runs on Android 11.0 so you can install your favourite reading, drawing or browsing apps. Combine this with 4GB of RAM, a 4,500mAh battery and dual 0.8w speakers and you have a powerful tablet that you can look at for hours without getting any eye strain. It even comes with a low latency 4,096-level stylus for natural feeling notes.



$1,658 | makermade.com

2021 MakerMade M2 CNC kit

Perfectly cut wood with this computer controlled DIY router.

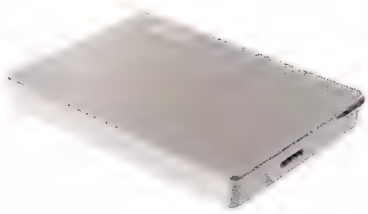
If you're wanting to up your design game or even make, say, a timber PC case then you're going to need the help of a CNC router to make all the bits as precisely as possible. MakerMade's M2 CNC mill is one of the only DIY computer controlled router devices that you can hang from a wall at home. The package comes with software included so all you need is a little 3D modelling skill and this CNC can cut you anything you can dream of. The MakerMade community have plenty of projects you can try yourself, for those needing additional inspiration.

NZ$687 | kck.st/2UcGzcg

Brake Ace

Faster mountain biking without needing to be fitter.

The Brake Ace is a sensor that attaches to your mountain bike's brakes and measures how you use them on downhill tracks to help you improve performance. Tracking intensity, duration, front/ rear balance and caliper temperature, the sensors allow you to keep an exact map of how you brake and pegs it to a GPS map. By comparing multiple runs or different users the software can then highlight the places with the biggest opportunity for improvement.

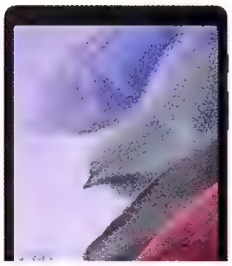


4TB $149 | anz.dynabook.com

Toshiba Canvio Flex

Slow and steady wins the economic race again.

We've had external USB connected SSDs and even ultra fast PCIe portable drives for years now, so we'd all but forgotten that you could even still buy portable mechanical HDDs. As you can see by Toshiba's recently released 210g Canvio Flex external HDD that there has been almost no development over the last few years, except maybe on price. If you are short on space, rather than on time then maybe it is worth looking at the economic argument for a portable mechanical drive again. 4TB for under $150 is pretty hard to beat if you can live with 125MB/s read and write speeds.



$249 | samsung.com/au

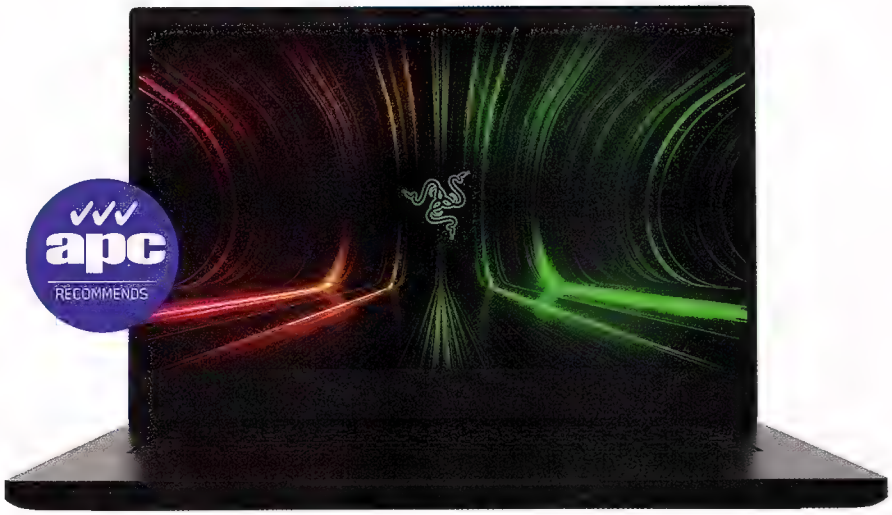
Samsung Galaxy Tab A7 Lite

Is this the perfect present for lockdown syndrome?

This new 8.7-inch tablet from Samsung is designed to be a more affordable entry to the tablet space for those spending more time at home. The tablet uses an 8-core MediaTek CPU that is powerful enough for light entertainment and web browsing, but it'll throw up a bit of lag if you hoard too many tabs. You get 32GB of on board storage but there's a MicroSD card slot to expand that much further. There's also a 5100mAh battery with 15W adaptive fast charging that should keep the 180 pixel per inch screen going for days under moderate use.

REVIEWS

THE HOTTEST GEAR LABS TESTED



$4,999 | www2.razer.com/au-en

Razer Blade 14

Razer's classic ultra-portable gaming laptop goes all AMD, but is it enough to balance the premium price tag?

The Blade 14 from Razer is a sleek looking Ultrabook that weighs under 2kg and is less than 2cm thick, so it doesn't look out of place up against today's best professional laptops. This is why it's perhaps a little surprising to see that you can get the Blade 14 with the biggest Nvidia GeForce RTX 3080 in it. It's not a full-fat 3080 mind you – the device's GPU TDP is capped at 100W, about two thirds of the maximum power allocation this GPU can be used with in a laptop according to Nvidia. This means that in addition to looking great, the most expensive Blade 14 is also an exceptionally good way to burn money, since you're unlikely to see even 10 percent performance increases in graphics applications over the alternative RTX 3070 Blade 14.

Other than the $4,999 RTX 3080 model and the $3,999 RTX 3070 Razer Blade 14 devices, you can also get a unit with an RTX 3060 for $3,099. While all three of these units feature one of AMD's latest Ryzen 9 5900HX CPUs, 16GB of RAM and 1TB hard drives, only the two more expensive configurations get a Quad HD 165Hz display, with the entry level model settling for a FullHD 144Hz display. We really like the choice of a 1440p fast monitor on this device because it allows gamers to get competitive frame rates online, without sacrificing pixel density for working on.

While the 3080 model isn't good value, the 3070 isn't exactly the best we've seen either. Something like Asus's TUF Gaming A15 offers comparable performance for $1,600 less. Granted the A15 is a more traditionally shaped gaming rig that's about 30 percent heavier and 50 percent thicker and we haven't seen too much in the way of 3070 Ultrabooks on the market (other than the frequently-sold-out $3,099 ROG Zephyrus G15). You're definitely paying a premium for the slim Blade 14 3070 form factor, but if that's what you're after it's the only place you can get it right now.

You won't have any issues running demanding work applications on the eight-core 16-thread Ryzen 9 CPU, which is up there with the best laptop processors available. High performance gaming is very much in this device's wheelhouse too, with demanding 1080p games pushing above 80 fps on ultra settings on the 3080 unit we tested. Based on our tests of other similarly powered 3070 devices the middle Blade 14 won't be far behind, while the 3060 nets closer to the 60fps mark for modern 1080p titles on Ultra settings.

The 63Wh battery is a little disappointing, lasting only one hour and 40 minutes in PCMark's Home office benchmark. It can stretch this to six hours and 15 minutes when under a lighter load like 1080p movie playback which isn't bad for this size battery.

A decent amount of fast PCIe SSD storage, a nice membrane keyboard and a reasonable selection of interface options round out a nicely designed laptop.

JOEL BURGESS

SPECS

W10 Home 64-bit; 14-inch 165Hz display @ 2560 x 1440 pixel resolution; AMD Ryzen 9 5900HX CPU, Nvidia GeForce RTX 3080 GPU (100W TDP); 16GB RAM; 1TB PCIe SSD; 63Wh battery (6h 15min 1080p movie playback); 32x22x1.7cm; 1.78kg.

Best result

	Razer Blade 14	Asus TUF Gaming A15
PCMark 10 - Overall (score)	6,905	6,823
Max CPU Temperature (C)	92	91
1080p movie playback (HH:MM)	06:14	06:18
HWBot x265 - 1080p (Ave fps)	57.84	55.879
3DMark Time Spy (score)	9,390	8,630
The Division 2 - 1080p Ultra (fps Av.)	82	99
CrystalDiskMark Read (MB/s)	3,507	3,267

A nicely designed gaming Ultrabook that you'll pay a premium for.

★★★★☆

US $1,799 | rog.asus.com/au

Asus ROG Strix G15 Advantage Edition

Does this all-AMD configuration actually provide the AMD Advantage?

Considering it's a 15.6-inch 1080p gaming laptop from Asus, you'd be forgiven for thinking this is just another generational update, but the Advantage Edition Strix G15 is actually rather unique. First off, this device uses AMD Ryzen 9-5900HX CPUs that are attached to the cooling architecture using liquid metal rather than thermal paste – allowing up to 14 degrees better cooling, according to Asus. The Advantage Edition pairs this CPU with an AMD Radeon RX 6800M GPU to get the amplified performance benefits known as 'AMD Advantage'. The bump is up to 11 percent on some titles.

There's a wide array of options for the standard Strix G15, offering various combinations of AMD,Intel and Nvidia components, but there's only the one Advantage Edition. This system comes with 16GB of RAM and a 512GB PCIe SSD. The one option you do get is to choose between a pro-grade 300Hz 1080p display or a higher resolution 1440p monitor that runs at 165Hz. Both are excellent gaming options that are nicely balanced against the device's capabilities, so it's just a matter of preference.

We didn't have the local RRP as we went to press, the US RRP is $1,800 but you can buy the ROG Strix G15 with a Ryzen 7-5800H and a GTX 3070 for $2,799 so we expect it to cost about the same.

Asus has tweaked this machine to get the most performance possible and it really shows in certain benchmarks netting between seven and 10 percent bumps over other recent Ryzen 9-5900HX laptops in media encoding benchmarks and spikes of up to 28 percent improvements in certain general benchmarks. This means it's pretty much on par for general work tasks as Intel's 11th generation i7 and i9 mobile processors.

We haven't tested enough 6000 series Radeon laptop GPUs to know just how much of an 'advantage' you get from all AMD parts, but you can expect this processor to perform en par with higher powered 3070 devices (125W) or lower powered 3080 mobile GPUs (100W). This means 80+ fps on modern titles at FullHD using Ultra settings and over 50 on higher resolutions or ray tracing scenarios.

SPECS
W10 Pro 64-bit; 15.6-inch 300Hz display @ 1920x1080p or, 15.6-inch 165Hz display @ 2560x1440 pixel resolution; AMD Ryzen 9 5900HX CPU; AMD Radeon RX 6800M GPU; 16GB RAM; 512GB PCIe SSD; 90Wh battery (8h 52min 1080p movie playback); 35.4x25.9x2.3cm; 2.3kg.

The overall aesthetic of the Strix G15 range is great, with a novel vent design, edge RGB lighting and an interchangeable chassis piece that allows you to include a pop of red, grey or black to the chassis. The RGB and system control software that come included with the Strix G15 laptops feel genuinely useful and allow you to understand and tweak your system's performance to get the most out of it at all times. It does miss out on a webcam and the 512GB of storage is small for a gaming laptop.

The G15 Advantage Edition comes with a generous 90Wh battery that has been optimised to last over eight hours in general work conditions and closer to nine hours for 1080p movie playback. For a gaming laptop it's the best we have on file by a long margin. From the looks of things there are a bunch of Strix G15 configurations that we'd recommend picking up, but the ROG Strix G15 Advantage edition is a standout option that will likely end up being one of our favourite gaming laptops of 2021. JOEL BURGESS

This all-AMD gaming laptop offers standout performance and unbeatable battery life.
★★★★★

Best result

	Asus ROG Strix G15 Advantage Edition	Razer Blade 14
PCMark 10 - Overall (score)	7,225	6,905
Max CPU Temperature (C)	84	92
1080p movie playback (HH:MM)	08:52	06:14
HWBot x265 - 1080p (Ave fps)	57.84	
3DMark Time Spy (score)	10,949	9,390
The Division 2 - 1080p Ultra (fps Av.)	79	82
CrystalDiskMark Read (MB/s)	3,021	3,507
CrystalDiskMark Write (MB/s)	1,623	2,774

$2,799 | dell.com/en-au/shop

Alienware M15 R5

Is Dell's latest AMD gaming laptop out of this world or just space junk?

Dell has decided to split the AMD and Intel variations of its powerhouse M15 Gaming laptop into two categories, labelling all the Ryzen based units R5 and anything Intel based R6. The Ryzen 5000 series has been around since the start of the year and Intel's 11th generation H series – which only arrived on laptops in June – so the naming convention makes sense, but the race between the two is closer than the labels lets on.

The M15 R5 comes with either an AMD Ryzen R7 5800H and 512GB of storage or an R9 5900HX CPU with 1TB of space. The former you can pair up with a Nvidia GeForce RTX 3050 Ti GPU for an RRP of $2,499 or an RTX 3060 for $2,899, while the latter is only available with an RTX 3070 for $3,599. These rates aren't particularly competitive, especially when they all get a pretty standard 16GB RAM allocation, but we have seen considerable discounts around. The 5900HX unit, for example, has been available for $2,799, which is pretty reasonable – but you can get the Asus TUF Gaming A15 with comparable specs for $2,399 if you are willing to sacrifice a little on chassis materials.

The Alienware M15 R5's does have a particularly nice build quality. The soft finished metal chassis looks and feels elegant, there's design references to Dell's longstanding gaming range in the vents and t-hinge screen, and the mSeries AlienFX keyboard is one of our favourites on a gaming laptop, feeling almost as good as a stand-alone mechanical keyboard. This strong body carries a 15.6-inch 165Hz FullHD gaming monitor with 3ms response time. While this screen is gonna' be fine for enthusiast gamers, it's not the best value we've seen. Comparable units throw in 240Hz and even 360Hz displays with this kind of setup for similar and even sometimes lower prices.

There isn't a heap of difference in the general work performance of the Alienware M15 Ryzen 9 5900HX and the Ryzen 7 5800H processors. In fact, the Asus TUF Gaming A15's Ryzen 7 outperformed Alienware M15 R5's Ryzen 9 5900HX by up to 15 percent on some of our multi-threaded general work tasks. We suspect this was due to a less than optimal cooling architecture since it was pretty easy to get the Alienware to spike above 100 degrees (we hit 103 in testing), so having the top Ryzen processor here doesn't make much difference. In media encoding the Ryzen 9 beat Intel's Core i7-11800H on an Aorus 15P YD by up to 15 percent, but in general work benchmarks it was generally 10 to 25 percent behind.

Graphically the Alienware M15 R5 we tested with an RTX 3070 hit the sweet spot in terms of performance offering 60+ frames per second on Ultra 1080p settings for all the titles we tested. F1 2020 and *Sid Meier's Civilization VI* even managed 150 frames per second to max out its screen refresh rate.

The 83.4Wh battery was reasonable for a gaming laptop but a bit disappointing compared to other 5000 series Ryzen machines netting just 2 hours and 53 minutes in PCMark 10 and 4 hours 36 minutes in 1080p movie playback.

JOEL BURGESS

SPECS
W10 Home 64-bit; 15.6-inch 165Hz, 3ms display @ 1920x1080 pixel resolution; AMD Ryzen R9 5900HX CPU; Nvidia GeForce RTX 3070 GPU; 16GB RAM (3200MHz); 1TB PCIe SSD; 83.4Wh battery (4 hours 36 min 1080p movie playback); 35.6x27.3x2.3cm; 2.69kg.

Best result

	Alienware M15 R5	Aorus 15P YD	Asus TUF Gaming A15
PCMark 10 - Overall (score)	5,953	7,258	6,823
Max CPU Temperature (C)	103	89	91
1080p movie playback (HH:MM)	04:36	04:07	08:18
HWBot x265 - 1080p (Ave fps)	58.805	56.609	49.084
3DMark Time Spy (score)	9,596	10,915	8,630
The Division 2 - 1080p Ultra (fps Av.)	81	97	99
CrystalDiskMark Read (MB/s)	3,463	7,014	3,267
CrystalDiskMark Write (MB/s)	3,128	5,093	2,543

A decent gaming laptop with a nice keyboard that isn't overly competitive on price.

★★★☆☆

$2,299 | www.rog.asus.com

Asus ROG Strix XG43UQ

Do you really want a monitor in the living room?

We baulked when we saw Aorus' 43-inch gaming monitor last month but now here's Asus with a straight-up competitor. Which is best?

These beasts are designed for the living-room and offer features that a TV typically doesn't. That means there's no tuner and no integrated, high-quality image processor for live TV and streaming services. However, there are PC-friendly inputs, a reflection-free, matte screen, firmware which offers gaming features and the potential for a fast, 144Hz refresh rate (120Hz for consoles). You'll need a recent, beefy graphics card to make the most of it.

The XG43UQ has some pretty nasty port placement. While on the right there are two USB-A ports, a USB-B, an HDMI port and two 3.5mm audio jacks, the remaining DisplayPort and HDMI ports are low near the base, downfacing and hard to reach without moving the monitor.

A monitor this size really isn't great for work: moving your head around to see different parts of the screen gets tiring quite quickly. We found it best to focus attention on one quadrant and glance around at other windows on the screen when needed. Asus recommends a magnification of 300 per cent when working with Windows but this makes a mockery of the 3,840 x 2,160 resolution, as it only leaves room for one window. However, we quickly saw why. Even with the large screen, some lettering was not as sharp as it should be – there were blurry colour fringes surrounding some letters. It's because Windows uses RGB subpixels for its TrueType fonts but the XG43UQ uses the reversed, TV-typical, BGR layout and Windows can't adapt. It means that working with text and office work for prolonged periods is not particularly pleasant.

That shouldn't be much of an issue when using the monitor for its primary job – PC gaming in the living room but there were some issues here too. The 1ms response time of the panel refers only to the cinematic MPRT rating. This, combined with the VA panel meant that some image smearing was evident. There are five (count'em) levels of overdrive to counteract this but none of them managed to hit a sweet spot. Casual gamers won't be too bothered but you'll see some weird ghosting of edges in games (and movies too) because of it. Nonetheless, colours are vibrant and the 1,000-nit high-contrast, HDR ability works well with some lighting effects popping out of the screen.

SPECS
43-inch, matte, 3,840 x 2,160, 10-bit, VA, 144Hz LCD. 1ms MPRT response time. 1,000 nit brightness. 4,000:1 contrast. 90% DCI-P3. HDR10, VESA DisplayHDR 1000. FreeSync Premium Pro. DisplayPort 1.4, 2 x HDMI 2.1, 2 x HDMI 2.0. 2 x USB 3.0, USB-B, 2x 3.5mm audio jack. 2 x 10W speaker. IR Remote. 975 x 722 x 374 mm, 15.3KG.

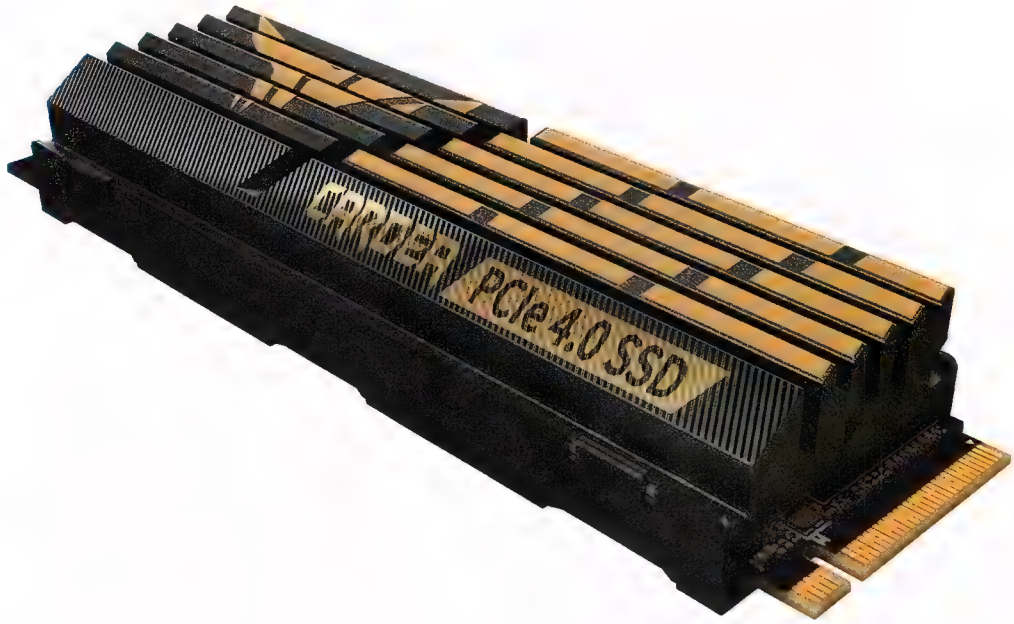
Gaming OSD features include an on-screen crosshair, Dynamic Shadow Boost (to reveal enemies in dark areas), on-screen monitoring readouts and timers. You can navigate through it using the included remote, four buttons to the side or Asus' DisplayWidget software. Meanwhile the speakers get impressively loud and offer good fidelity. The large, tri-pod stand is somewhat unwieldy but it's sturdy and offers a degree of tilt.

It's not bad, but it's not the premium product we expect from ROG. To cap it all, there's the price: at $2,299 it's $600 more than its Aorus rival which performs better. There's little reason to buy this.

NICK ROSS

Average performance and poor value: not what we're used to from ROG.

★★☆☆☆



$699 | www.teamgroupinc.com

Teamgroup Cardea A440

A fast PCIe 4.0 SSD suitable for all systems.

The Teamgroup Cardea A440 is one of a new crop of drives equipped with the Phison E18 controller. With read and write speed ratings of 7,000/6,900 MB/s respectively, it all but hits the limits of a PCIe 4.0 x4 link.

The Cardea A440 is a standard form factor 2280 M.2 drive. It makes use of Micron 96-Layer TLC NAND and a Phison PS5018-E18 controller; only the 2TB model we have for review will hit the full 7,000/6,900MB/s, and the 1TB model comes with a slightly slower 5,500 MB/s write speed. You have a choice of a chunky metal heatsink or a thin graphene-based strip. Alternatively, if you have a motherboard or laptop with an integrated heatsink, you can leave it bare. The 2TB model features a very competitive 1,400 TBW endurance rating to go with a five-year warranty. That rating is actually better than the WD SN850 and Samsung 980 Pro. Notably, the drive doesn't have any encryption support.

Can the Cardea A440 challenge the mighty SN850? In CrystalDiskMark we see over 7100MB/s and 6700MB/s sequential read and write speeds. The A440 delivers very good 4K write performance and its low queue depth write IOPS results are also strong. In fact, its write performance is as good as any drive on the market. It does lag a little in read performance though. Using the large heatsink, we saw a peak temperature of 63 °C under a heavy sustained write load. A good result.

Current generation PCIe 4.0 drives offer so much sequential, random and IOPS performance that it's becoming harder to differentiate between them outside of benchmark results. Tangible differences during day-to-day use are often undetectable. Though the Cardea A440 might not catch the likes of the Samsung 980 Pro or WD SN850 in the all-important read benchmarks, other characteristics such as endurance ratings, price per gigabyte and operating temperatures weigh heavily. At the time of writing the 2TB Cardea A440 was only available at one retailer in Australia, priced at $699. This makes it one of the most expensive 2TB drives on the market and it's more expensive than other Phison E18 equipped drives.

That price hurts it, but that's at one store only. If the 2TB A440 drops in price it will become a lot more interesting. We like having a choice of heatsink, its write performance is excellent, and its endurance rating is also very good. Should you buy it though? It depends on what you use the drive for. We think this drive is suitable for content creators or users who really value write performance.
CHRIS SZEWCZYK

SPECS
PCIe 4.0 x4; Phison PS5018-E18 controller; Micron 96L TLC NAND; 7000 MB/s sustained read, 6,900 MB/s sustained write, 650K/700K read/write IOPS; 1400 TBW endurance; five year warranty.

The A440 offers awesome write performance, installation flexibility and high endurance, but it faces stiff price competition

★★★½☆

Best result

		Western Digital Black SN850 1TB	TeamGroup Cardea A440 2TB
Crystal Disk Mark Sequential Read MB/s		7,071	7166
Crystal Disk Mark Sequential Write MB/s		5,229	6,764
Anvil Storage Utilities	4K Random Read MB/s Queue Depth 1	82.42	68.80
	4K Random Read MB/s Queue Depth 4	300.22	268.15
	4K Random Write MB/s Queue Depth 1	255.17	270.62
	4K Random Write MB/s Queue Depth 4	879.44	905.60
Anvil Storage Utilities	4K Random Read IOPS Queue Depth 1	21,099	1,7612
	4K Random Read IOPS Queue Depth 4	76,855	6,8645
	4K Random Write IOPS Queue Depth 1	65,322	69,279
	4K Random Write IOPS Queue Depth 4	225,135	231,833
Internal File Copy 30GB of mixed file sizes (secs)		27	27
Final Fantasy XIV: Stormbringers Scene Loading Time (secs)		7.680	8.340

$2,199 | www.aorus.com

Aorus FO48U gaming monitor

What a difference panel technology can make...

Oh come on! After recently suffering through reviewing two ridiculously sized, 43-inch, 4K gaming monitors from Aorus and Asus, the former has sent in a 48-inch unit! What's really weird, though, is that we absolutely love it.

The main reason here is the panel technology. Whereas the 43-inch models were constructed using TV-oriented LCD-panels that struggled to be useful for anything other than gaming at a distance, the FO48U is an OLED screen. The first thing you notice is it's incredibly thin (at the top, anyway) but it's still heavy owing to dense electronics that cover the lower-back: it tips the scales at 15KG. There's no stand, just two pairs of feet at each end – it basically resembles an OLED TV.

The next thing we noticed was the Windows Desktop. The 43-inch monitors struggled to display crisp and clear text for a variety of reasons. However, while fonts display a slight blur around the edges, the uniformity of the minor aberration means that even small text is comfortable to read. I sat in front of it working for a week and didn't have any eye-strain issues. Even the very glossy screen isn't a problem. While it acts as a mirror when all black, with bright Windows being displayed, reflections never bothered us. It fends off glare well, too.

But this is a gaming monitor, so how does it perform? Unlike Aorus' other recent launches this screen only goes up to 120Hz rather than 144Hz. It sports two HDMI 2.1 ports (and a DSC-capable DisplayPort 1.4 port) to facilitate this, which will be a boon for current-gen console gamers. The near-infinite contrast of OLED (plus its HDR10 rating) instantly makes its presence felt, with detail being present in both bright and dark areas. However, the low (130-nit in normal operation) brightness rating is noticeable. While dark scenes in *Far Cry 5* have bright, glowing objects jumping out of the screen, the relatively low peak brightness means that things top-out very quickly – it's just like looking at a white screen: we expect to be shielding our eyes like we're looking at the sun! Still, few people will complain, especially as colours are incredibly rich and vibrant and gradients are smooth in both colourful and monochromatic transitions. The 120Hz speed and OLED technology mean all motion is smooth and crisp when shooting things and driving fast too.

SPECS
47.5-inch; glossy; 3,840 x 2,160; 10-bit, OLED; 120Hz LCD; 1ms GTG response time; 130 nit brightness; 135,000:1 contrast; HDR10, 98% DCI-P3; 1x DisplayPort 1.4, 2x HDMI 2.1. 2x USB 3.0, 1x USB-B, 1x USB-C. 2x 15W, 1x 20W speakers; 1069 x 612 x 43mm, 15KG.

Aorus' gaming features include onscreen crosshair, Black Equalizer for revealing enemies in shadows and a KVM feature that lets you use one keyboard/mouse combo with two different computers. OSD features can be accessed via a joystick-button, Windows app or the included IR remote. The speakers get loud but are a bit muddy with poor fidelity.

Ultimately, we seriously like the $2,199 FO48U but it's worth tarrying. If you're planning to put this in your living room, then LG's 48-inch C1 costs $200 more but switches in a bunch of great TV features (while still including many gaming enhancements plus 120Hz panel speed) at the expense of only a DisplayPort and USB-C.
NICK ROSS

A fantastic, giant gaming monitor. But it has competition from TVs in the living room.
★★★★★

$1,499 | www.gigabyte.com

Aorus FI32U gaming monitor

Could this be the sweet spot of monitors?

Firstly, a thank you. Thank you Aorus for sending me a nice, small, reasonably sized monitor to review. The recent 43-inch models have been hurting my neck while this sober-sized 32-inch monster is far more comfortable to use. It also sports a full, 4K resolution and a 144Hz refresh rate. Sounds promising...

The FI32U has an IPS panel which historically means it should be great for colour reproduction, okay for motion smoothness, and mediocre for contrast. However, this is Aorus' 'SS IPS' supercharged version which promises, "Splendid colour and furious speed." Does it deliver?

In terms of motion smoothness, the 144Hz screen has both grey-to-grey and MPRT response times of 1ms and this, coupled with Aorus' electronics, achieved negligible ghosting or blurring even in fast and frantic shoot'em ups at 4K.

In terms of colour, we were impressed. Although it 'only' supports 90 per cent of the difficult DCI-P3 colour gamut, which might put off designers seeking high levels of colour accuracy, everything is rendered bright and vibrant.

At 350 nits it doesn't have the brightest rating – it certainly isn't a proper HDR display – but it certainly gets bright for office work, general use, and gaming. However, the relatively low contrast rating of 1,000:1 can manifest when engaging in any dark multimedia with detail (and enemies) getting lost in shadows a little too easily. Switching to the monitor's FPS pre-set mode brightens dark areas up but the Black Equalizer feature works best at destroying picture quality to reveal baddies hiding in the shadows.

It's also very good for office work, with a crisp and clean Windows Desktop being displayed and small fonts being rendered readably without distortion.

Ergonomics are good too. The two-piece stand is solid and clips together without tools. It tilts, swivels and rotates to generous degrees and can be raised and lowered by a full 13cm. There's even a handle at the top should you want to carry it.

There are two HDMI 2.1 ports to allow 144Hz refresh rates at the full, 4K resolution (and 120Hz for current-gen consoles). There's also DisplayPort 1.4, two USB-A 3.0 ports and a USB-C. The latter can be used as a KVM switch whereby you keep the keyboard and mouse attached to the monitor and can use them with different computers – quite useful in these days of working from home when you might be regularly switching between home and work PCs.

SPECS
31.5-inch, matte, 3,840 x 2,160, 10-bit, IPS, 144Hz LCD. 1ms GTG & MPRT response times. 350 nit brightness. 1,000:1 contrast. 90% DCI-P3. FreeSync Premium Pro. 1x DisplayPort 1.4, 2x HDMI 2.1. 2x USB 3.0, 1x USB-B, 1x USB-C, 2x 3.5mm audio jack. Tilt -5°+20°, Swivel -20°+20°, Pivot -90°+90°, height adjustment 130mm. 717 x 424 x 71mm, 10.9KG.

The OSD is accessed by an intuitive joystick-button at the base of the screen or Gigabyte's OSD SideKick software. This gives access to game-friendly features like crosshairs, PC component monitoring stats, timers and Picture in Picture – which is useful for following walkthroughs or locating any streamers you might be playing against(!)

At $1,499 it's certainly not cheap but it's about as good as you get from any monitor in terms of size, resolution, features and performance, without getting into the silly-money, rear-lit HDR options that cost twice as much. Ultimately, it's great for work and play and we fully recommend it.
NICK ROSS

It's good at everything. The pinnacle of mid-range monitors.
★★★★★

$269 | www.dahuasecurity.com

Dahua LM28-F420

Is 4K on a shoestring possible, or are the compromises too considerable?

It wasn't that long ago that you could expect to pay a pretty penny for the privilege of putting a 4K monitor on your PC, but these days you don't have to fork out the big bucks for high pixel counts. One of the newer players in the local budget high resolution display is Chinese Security company Dahua Technology. The 28-inch LM28-F420 4K monitor is the first product we've looked at from Dahua, but our first impressions are pretty good.

The 28-inch monitor offers a generous workspace with enough room for you to run two documents side-by-side comfortably. Thanks to the high resolution and good 300nit brightness, details are clear and documents are easy to read and edit. When you switch to media the screen holds its own, making 4K YouTube clips and streamed UHD content look extremely clear.

This unit only features standard dynamic range, 8-bit colour processing, but it does offer 100 percent sRGB colour reproduction. By my eye, the screen's colour will vary from other monitors, so while it looks perfectly fine for media and the web, you wouldn't want to trust it with any pro-level photo editing.

The panel uses LED technology in a Vertical Alignment (VA) pixel arrangement, which goes some way to explaining why it has an impressive looking 1,000:1 contrast ratio and overall brightness. Traditionally this type of display hasn't been as good as IPS screens in both viewing angle and response rate but they don't seem to be an issue here. There's definitely some colour variation as you move anything past 30 degrees, but the effect is subtle and most onscreen information is visible up to 178-degrees. Response time is also rated at just 5ms, so don't fret about lag or display issues while gaming.

With a 60Hz refresh rate you're not going to get far in online first person shooters, but for any games you want to play at UHD on your own, the display does include Freesync to keep any unwanted artifacts from affecting this high-res gaming display.

With two HDMI 2.0 ports and a DisplayPort 1.2, there's enough inputs to get your screen running at the highest resolution possible and while we wouldn't recommend relying on them permanently, the screen does have backup speakers for when you're in a bind.

SPECS
28-inch VA display @ 3840 x 2160 pixel resolution; 5ms response time; 300nit brightness; 60Hz refresh rate; 1000:1 contrast; 178 degree viewing angle; 1 x DP1.2, 2 x HDMI2.0; 100% sRGB; 63.8x36.9x5.7cm (without stand), 8.8kg.

Don't expect much in the way of advanced features or sophisticated menu interfaces: picture-in-picture, colour presets and gaming tools are well beyond the scope of this display. Kogan and Acer have more feature-rich 28-inch 4K displays that are often on-sale at around the $300 mark, if you're happy to spend a bit more. The VESA display stand lacks any embellishments, but it feels solid and allows the screen to tilt forward or backward, level and even rotate up to 90 degrees in one direction.

Available at a number of online retailers for $269, the most significant perk of this 4K screen is the price. While 28-inches should be more than enough for most, Dahua also offers a 32-inch model with similar specs for around $400.

JOEL BURGESS

A no-frills 28-inch 4K work display that is bright and can even handle high res gaming.

★★★★☆

$550 | www.draytek.com.au

Draytek Vigor2865ac

A performance focused multi-WAN VDSL2 router with a focus on versatile connectivity.

For the Draytek Vigor2865 series connectivity is key, and it sports both a WAN port and an ADSL2+ / VDSL modem. Even better, it supports the latest VDSL 35b Supervectoring spec. For those who don't live and breathe modems, 35b allows DSL speeds of up to 300 Mbps. As a comparison, the older Vigor2865 supported VDSL 30a, which supported up to 200 Mbps, while many modems only do 100 Mbps. The 2865 also has 5 Gigabit LAN ports, but beyond that comes in a variety of models - the most basic with no Wi-Fi, VoIP or LTE. The 2865ac (as tested) adds 802.11ac spec Wi-Fi, while the 2865Vac has Wi-Fi and VoIP. The 2865L has a built-in LTE modem, and the 2865Lac adds Wi-Fi, but no VOIP. If you want both VOIP and LTE, the 2865V series can add two 4G modems via USB.

That's a lot of options, but gives a lot of flexibility for businesses to choose what they need, and match it with the hardware they already have. With LAN, WAN, LTE and Wireless WAN connections, it is possible to have up to six sources of internet, configured to work together, act as backups, or kick in when the extra bandwidth is needed. You also get comprehensive firewall, security controls and quality of service options.

The Vigor2865 series needs to be able to handle all these features, so includes hardware acceleration, and provides 800 Mbps of NAT and 130Mbps of SSL-VPN throughput – 1.6x and 2.9x faster respectively, compared to the older Vigor2862. You also get 60k NAT sessions, which is suitable for large networks with 50+ devices. The router also supports 32 VPN tunnels, and 16 SSL-VPN, plus 16 VLANs and 8 LAN Subnets. The AC spec Wi-Fi gives 400 Mbps on 2.4GHz, and 867 Mbps on 5GHz. In testing the Wi-Fi gave great results at 623 Mbps up close, and 316 Mbps at 10m range.

Right, so all that adds up to a modem router that gives small businesses loads of options for internet and network management. The actual DrayTek web interface is dense, but well laid out, and there are loads of support options and articles available online.

Where Draytek devices really shine is the ability to manage a network of compatible Vigor gear, such as switches and wireless access points. This is possible directly via the Vigor2865 web interface, but Draytek also has a software management solution – VigorACS. This TR-069 compliant software provides a central interface to manage compatible Draytek hardware, such as access points, routers and switches. It's a key feature for larger businesses, where the time savings alone can be significant.

The inclusion of 35B Supervectoring support is important for VDSL connected businesses, though this same option can be found on lower end Draytek routers. Where the Vigor2865 really shines is the hardware acceleration and network management options, which are critical for companies with larger or more complex networks. We also appreciate the wide range of 2865 Series models available, but it does mean you need to carefully match the models to your specific needs.

LINDSAY HANDMER

SPECS

WAN Port: 1x LAN/WAN, 1x RJ-11; LAN Ports: 5x RJ-45 1GbE; USB: 2x USB 2.0; Wi-Fi: 802.11ac; VPN Tunnels: 32; NAT Throughput: 800 Mbps; NAT Sessions: 60k; VLANS: 16.

It's hard to fault the Draytek Vigor2865ac, and its flexible yet high performance feature set is a must-have for many businesses.

★★★★☆

"In testing we managed 647 Mbps in close proximity to the router, which dropped to 94 Mbps across the house. Adding in a mesh node at the same location, we managed 313 Mbps instead."

$250 | www.tp-link.com.au

TP-Link Deco X20

An affordable yet fast and easy to use mesh Wi-Fi router.

We can't help but get excited about efforts to banish bad Wi-Fi, and the latest from TP-Link is the Deco X20. It comes in two models – the X20-DSL modem router, and the X20 mesh node units, which are available in multi packs. The X20 is part of the TP-Link Deco range, so is fully compatible with older Deco models, and can be happily slotted in to upgrade an existing network.

Both the X20 router and nodes use Wi-Fi 6 (AX1800 spec), with 1,200 Mbps available on the 5GHz band, and 574 Mbps on 2.4GHz. Wireless links between nodes use whatever combination of bands is fastest, rather than have a second dedicated 5GHz band. That's not an issue though, as the X20 is designed to be a mid range, fast yet affordable setup, rather than opting for the very best performance regardless of price.

The X20-DSL has four Gigabit LAN ports (and auto senses LAN/WAN for connection to existing broadband), as well as a VDSL2/ADSL2+ modem that supports up to SuperVDSL (350Mbps) speeds. The smaller X20 nodes have two LAN ports, and can be connected via cable for increased backhaul bandwidth. If you already have a router or modem, the X20 nodes can be connected via LAN or WAN and be the basis of your mesh network – the X20-DSL is only needed for the modem or extra LAN ports. While setup can be done via a web browser, TP-Link has a very polished app that walks you through the process. The app also gives in depth access to features such as parental controls, security, quality of service, and deeper networking options.

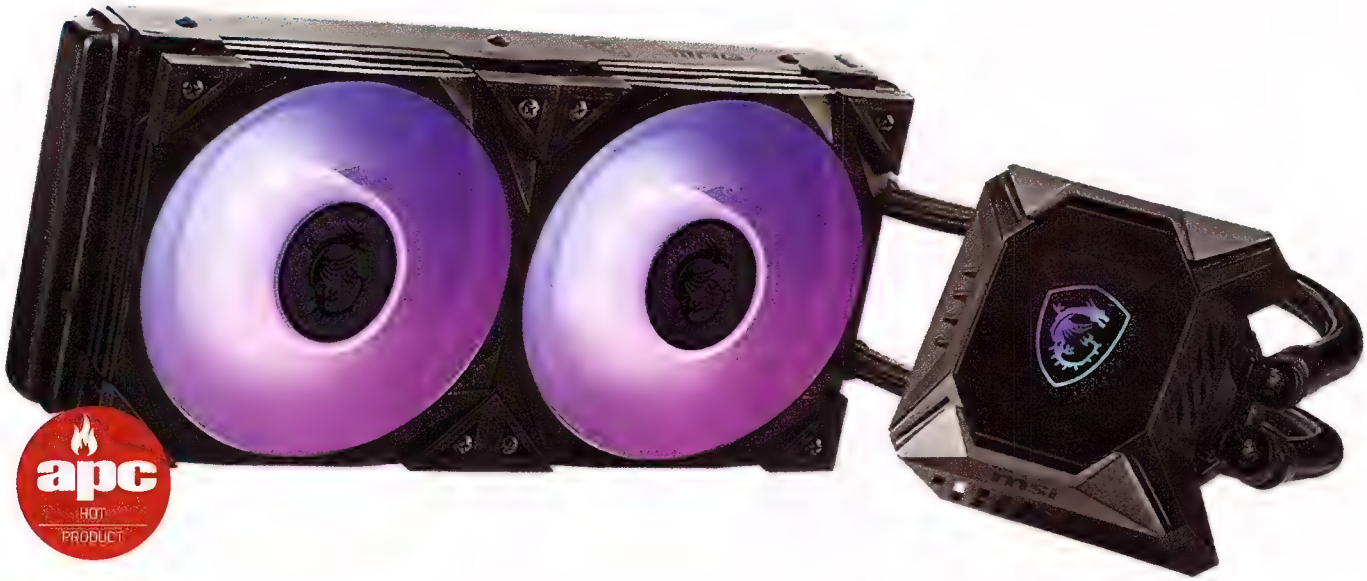
We tested the X20-DSL with two X20 nodes, and getting them connected and updated was very smooth and easy using the app. The ideal placements, and therefore access speeds will depend on your specific home, but TP-Link suggest the three units together can cover 530 square metres. In testing we managed 647 Mbps in close proximity to the router, which dropped to 94 Mbps across the house. Adding in a mesh node at the same location, we managed 313 Mbps instead. This is an excellent result, and the X20 punches above its weight for normal household use. Mesh node handover was almost flawless, and the X20 did a pretty decent job of making sure we were connected to the fastest node.

SPECS
Wi-Fi: 802.11ax; AN: 4x Gigabit Ethernet; Modem: ADSL2+/VDSL2; CPU: 1.5GHz Quad Core; App Management; Dimensions: 105 x 105 x 167mm.

Even with multiple devices on the network, including 4K streaming and file copies, the connection was reliable and fast. When unplugging a node, the X20 happily re-routed traffic to maintain the best connection.

Overall, the X20 is a great option for small through to large homes, who need reliable performance even with a multitude of devices connected. There are very significant savings if opting for a two or three multi-pack of the X20 nodes, at $200 for one, $300 for two and $350 for three. The $250 X20-DSL is great for those who need the extra functionality, and it's fantastic that all Deco products are compatible with the rest of the range. We were especially impressed with the premium experience offered by the X20, from the packaging through to the flawless setup and easy ongoing management.
LINDSAY HANDMER

Excellent performance for the price and a premium experience makes the X20 (and the Deco range) a fantastic option for home mesh networking.
★★★★½



$329 | msi.com

MSI MPG Coreliquid K240

A capable and well-featured AIO that can handle the most demanding CPUs.

The MPG Coreliquid K240 is aimed at the more premium end of the market. It sits comparatively priced and featured next to Asus' top-shelf Ryujin series. A 360mm version is also available for around $400.

MSI has added some very appealing new features for this new model. The pump block has its own dedicated cooling fan, and it's built around Asetek's 7th generation pump. The sizeable pop-on/off shroud serves to duct fan air around the CPU socket to cool the VRMs and other nearby motherboard components.

The pump head also has an LCD screen that can cycle through system information like the current pump and radiator fan speeds, and CPU temp. If you prefer there are also pretty patterns, or you can load your own images in. It's handled by the MSI CoreLiquid app, and you can also set it to display CPU and GPU frequencies – though there's a maximum of three bits of info at a time it can cycle through. The colours aren't as punchy as the Asus Ryujin's OLED screen, but still look good.

The CoreLiquid K240 (and the 360 version) doesn't use a fan and RGB hub, so there are several cables coming off the CPU block. These include a USB connector that needs to go on a motherboard header to allow control over lighting, the display and fans. It all made cable tidying around the CPU a minor fiddle, and you'll never achieve a perfectly clean look.

The performance, though, appears to be worth it. The 8-bladed radiator fans spin up to a maximum of 2500 rpm, though at all but the most aggressive settings spin well below that, and are usually unobtrusively quiet.

We tested the CoreLiquid K240 on an Asrock X570 Taichi with a Ryzen 5950X CPU. The system idled at around 39 °C using MSI's balanced mode with the radiator fans at 1,400 rpm, about what we expected. When running Super Pi, we saw temps sitting comfortably at around 59/60 °C in Balanced mode, with Silent mode adding another 2-3 °C to that, for a fan decrease to around 800 rpm. Not bad at all! Using MSI's Game Mode the fans ramp up more aggressively, but still kept the 5950X at a comfortable 63-64°C @ 1,500 rpm.

We then tested the limits of the cooler, using AMD PBO overclocking to allow the CPU to stretch its legs based (in part) on the cooler's effectiveness, it sustained 4.4GHz on all 16 cores with temps at 85°C, with the fans at a noticeable but not unpleasant 2,080 rpm. So there's a little headroom available should you want to create a custom profile that pushes the fans closer to the 2,500 rpm limit.

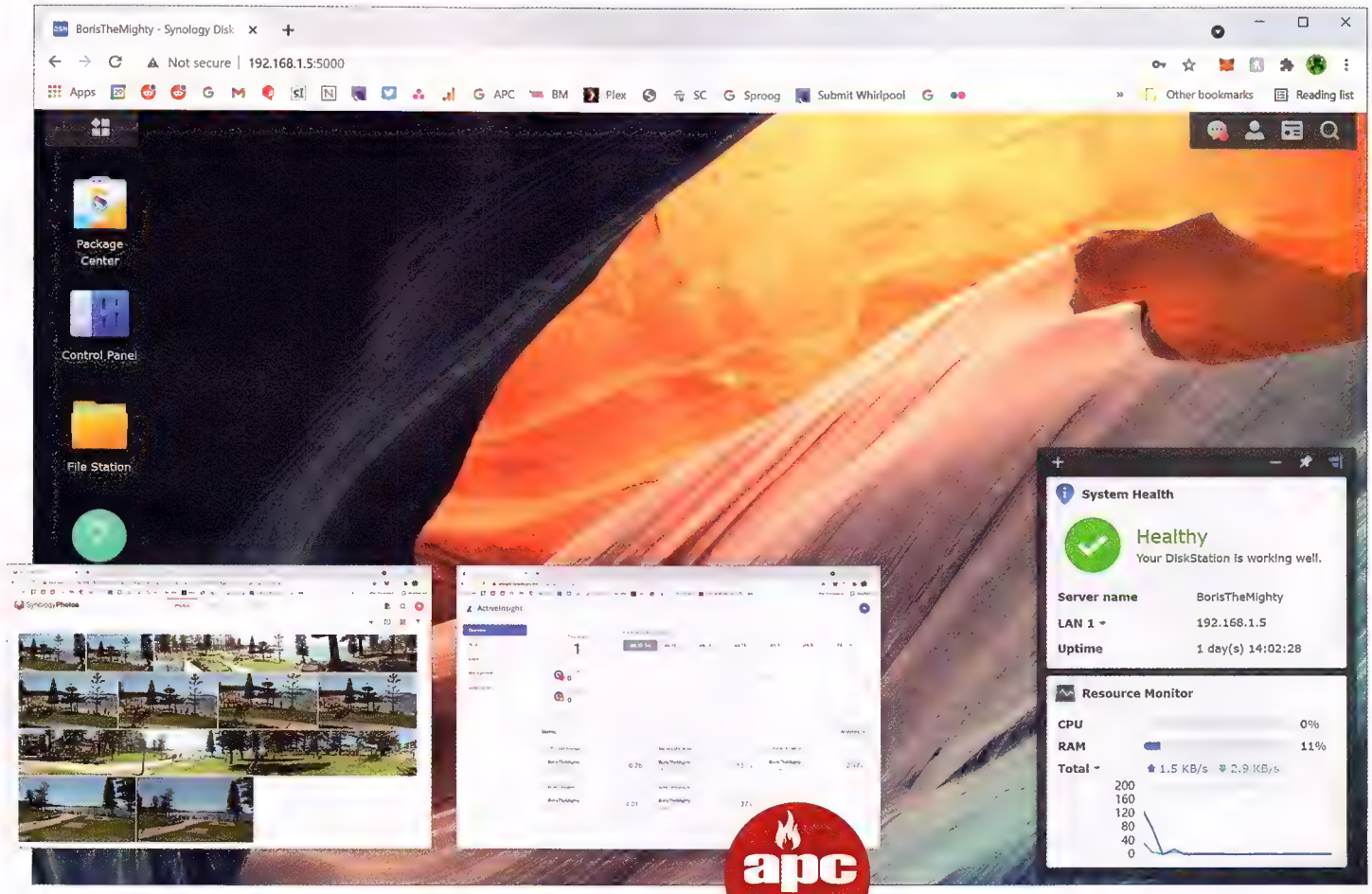
That the CoreLiquid 240 is able to maintain good low temps at relatively low fan speeds for heavy tasks indicates it could handle heavily overclocked systems, and this was the 240mm version – if your demands are heavier there's always the 360mm CoreLiquid and the performance we're seeing with the 240 would scale up well with the addition of a third fan and larger radiator.

BEN MANSILL

"The pump head also has an LCD screen that can cycle through system information like the current pump and radiator fan speeds, and CPU temp."

A fully-featured 240mm cooler with performance rivalling many 360mm AIOs.

★★★★½



Free | www.synology.com

Synology DSM 7.0

Synology's biggest ever upgrade is finally, officially launched. Is it worth the wait?

Synology launching its latest Disk Station Manager operating system is less of a poorly kept secret and more of a, "Well finally!" moment. Synology itself said that the core development was finished in early 2020. It's mainly been working on polishing features to ensure they would officially launch as bomb-proof and reliable as we'd expect from the popular NAS manufacturer. Even now though, Synology states that some core packages remain in beta and it can't guarantee that all (the many) third-party apps will work as intended.

Updating is simply a case of downloading the software and performing a manual update. It takes 10-20 minutes. Once in, you're invited to the new Hybrid Cloud feature called Active Insight, which automatically monitors your NAS from the cloud and alerts you to abnormalities. It can also back-up your configuration settings and offer two-factor authentication when signing in. The Hybrid Cloud feature set also includes improved file-sharing features and encryption to go with them.

The layout is modern – it's more like a webpage than DSM 6's Windows 95-looking OS – but the core features are where they always were. Primary benefits revolve around more intuitive, efficient and powerful storage management. There's also support for fast, Fibre Channel transfers, RAID 6 and SSD caching which speeds up small file management. For large video files, storage pools can now support a petabyte (up from 200TB).

Some of the most useful upgrades for business are to Storage Manager. The Drive Replacement feature automatically identifies dying drives and places them in a palliative-care-type storage pool before failure. This works in tandem with Auto Replacement whereby idle Hot Drives are automatically spun-up to take over before the storage pool degrades. A new Fast Repair feature makes this process up to 50 per cent faster by only processing used areas of a drive. Meanwhile Auto Repair will automatically repair the system without you having to sign in. There's also a Space Reclamation schedule to automatically reclaim un-used space from deleted folders (without impacting performance).

Nonetheless, a quick dose of reality appeared when we tried to upgrade the popular Plex Media Server app. It straight up wouldn't let us. Fortunately, a major strength of Synology quickly came to the fore… the massive community with extensive support documentation. Although the instructions for a manual reinstall were lengthy, they were straightforward – at least to the degree that anyone who has set up a NAS will be able to follow.

Another major upgrade is the new Photos app which combines the creaking Photo Station and Moments apps to benefit casual and professional photographers alike. It includes timeline sorting, face recognition, improved mobile and backup support plus improved collaboration features.

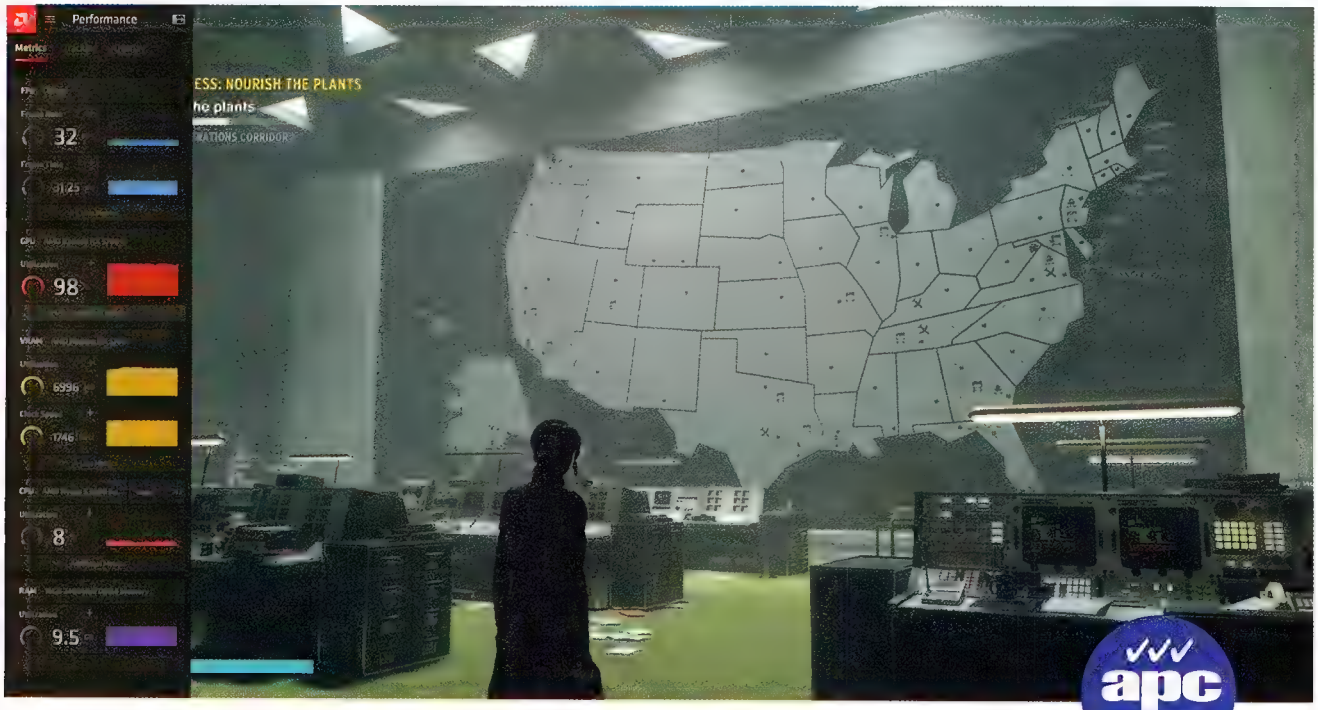
There are many other additions that are too numerous to list here but they revolve around improved user management, file sharing, automatic system updates, backups and data continuity.

Ultimately it's hard to imagine anyone stubbornly wanting to stick with DSM 6. It's a matter of when you'll upgrade, not if.

NICK ROSS

Free, simple to install and everything is improved. Just expect some compatibility issues with third-party apps.

★★★★★



AMD Radeon Software $Free | amd.com **Nvidia GeForce Experience** $Free | nvidia.com

Radeon Software vs. GeForce Experience

Battle of the, uh, utility software.

On a fundamental level, Nvidia's GeForce Experience software and AMD's Radeon Software (also known as Adrenalin) are exactly the same. Both offer device driver management and capture utility alongside specialised support for a variety of games. The dividing line, of course, is that Radeon Software is designed for use with AMD GPUs, while GeForce Experience is the app you need if you're rocking an Nvidia card.

It's not that simple, naturally. GeForce Experience has been around for a wee bit longer than Radeon Software, at least in its current incarnation, and it's not unfair to say that AMD clearly copied Nvidia's homework whenever Experience added a new feature. Both consistently recommend that you upgrade to the latest and most expensive GPU, for example...

This sort of software started life as simple driver update tools, designed to remove the need to manually track down the right drivers for your component on the manufacturer's website. The premise was straightforward enough: The software identifies the relevant components active in the system, then locates and installs the appropriate drivers automatically.

The Radeon overlay gives you as much information as you want, thanks to expanding toolbars.

Both pieces of software still do this, although installing new graphics drivers is hardly difficult. The program had to do more to become a selling point for AMD and Nvidia to push to consumers, so the rivals looked to the primary use of dedicated GPUs in desktop PCs and laptops: gaming.

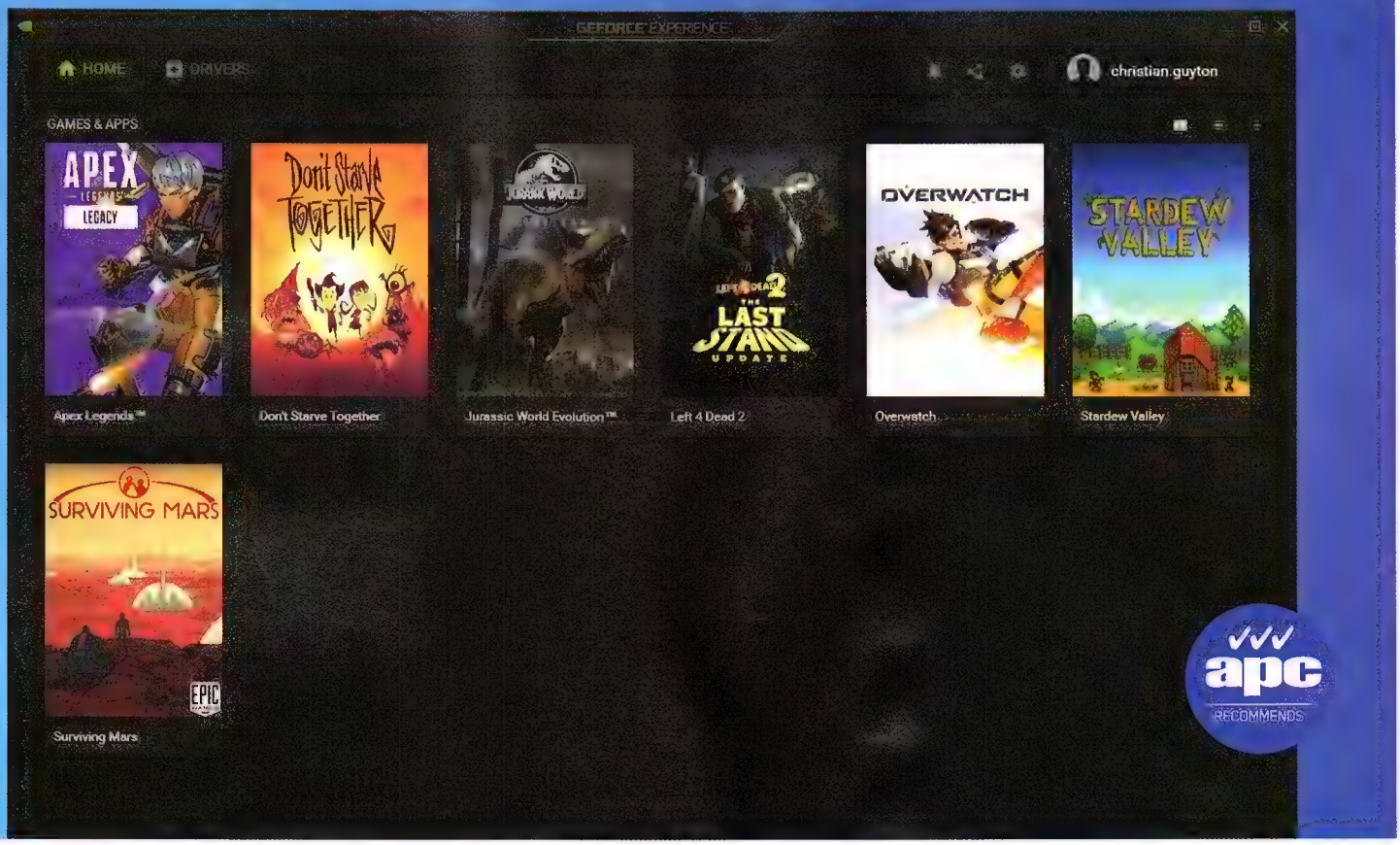
Capture software has long been a tricky business for PC gamers, so Radeon Software and Experience can both capture and record game footage for livestreaming or video production, each using an overlay.

Essentially, the software constantly records, enabling you to snip and save a juicy play like a DVR instant replay. High-res screenshots and GIFs are also only a few clicks away with both programs – ideal for social media snapshots. GeForce Experience calls its capture toolkit ShadowPlay, and boasts up to 8K HDR recording. Radeon Software is more low-key, with just a "Record and Stream" tab.

GeForce Experience has a leg-up on AMD in this arena, and it's called Nvidia Ansel. This is essentially a souped-up photo mode for around 200 supported games, enabling you to take crisp ultra-res screenshots or 360-degree images that can later be rotated when viewed, or experienced in VR. Nvidia also hosts a "Shot with GeForce" gallery on its website, where users can upload their best pics.

There's something to be said for how smoothly Nvidia's capture overlay operates. The Radeon Software overlay is a bit clunky in comparison; while it offers almost all the same features, Experience feels easier to use. Grabbing footage is snappy, with easily rebindable hotkeys for specific tasks. Experience also allows you to add filters to Ansel-supported games in real time, changing the lighting or color correction to suit your preferences. Both perform well for game capturing, but Team Green offers a subtly superior experience.

Boosting game performance is another key area, with AMD potentially taking back some ground. GeForce Experience readily optimises a game's graphical settings for you



automatically, enabling any baked-in Nvidia hardware features such as DLSS and G-Sync. Radeon Software does this, too, but also hands you more control over AMD-exclusive features.

There's plenty to choose from, too. Radeon Anti-Lag dynamically adjusts frame timing to minimise input lag, a vital inclusion for twitchy Valorant players. Radeon Chill alters your FPS in accordance with your GPU temperature, while the excellent Radeon Image Sharpening uses a contrast-adaptive algorithm to improve visual clarity with minimal performance impact. These settings have sub-settings, such as allowing you to set minimum and maximum FPS targets for Radeon Chill.

Sure, some of these boosts can be achieved on an Nvidia GPU without using GeForce Experience, but it's handy to have them all collated for easy use. Overall, Radeon Software feels better suited to the average gamer, but if you're trying to build a career and need capture software, GeForce Experience is the better choice.

What else can these programs do? Well, game-streaming is one increasingly popular feature, beaming gameplay live from your powerful gaming PC to different devices. Radeon Software has got you covered here; AMD Link is a free and easy-to-use app that connects to your PC and enables you to stream games directly to your device of choice, be that a laptop, phone, or smart TV. It's an excellent tool that can be used to play your favorite games remotely, although it does demand some excellent Wi-Fi on both ends.

GeForce Experience doesn't have the same clout when it comes to streaming to other devices. It does enable compatibility with the Nvidia Shield TV media player, enabling you to play PC games from your couch even if your PC is in another room, but this requires a Shield unit, and these start at $145. Nvidia did have a feature similar to AMD Link in the works – named Nvidia Gamestream – but that seems to have fallen by the wayside. Amusingly, AMD Link can be used on the Shield TV, reinforcing AMD's "any device" mantra.

The only other key feature is system monitoring, and there's only so much that can be said about that. Experience and Radeon Software both enable you to track stats like frame rates and temperatures on the fly, via an overlay or in the app proper.

"Ultimately, you're beholden to the software that your GPU adheres to – or none at all, as neither is mandatory."

Experience has several overlays, most of which are slyly removed from even Windows' screenshots.

Again, Experience offers a superior overlay here, with friendly sliders for adjusting specs such as voltage and fan speeds. Radeon Software has more detail in-app, which will please some users. If you want to know details such as your CPU's thermal current, AMD has got you covered. AMD's tool also includes a built-in web browser, but this feels superfluous.

Ultimately, you're beholden to the software that your GPU adheres to – or none at all, as neither is mandatory and there are plenty of alternatives; HWMonitor can handle component monitoring, while Windows 10's Game Bar is more than sufficient for quick and dirty game capture. These two pieces of software are both good at what they do and intuitive, and we'd probably give AMD a slight edge if we were forced to pick one winner, but the difference is small enough that it shouldn't be a deciding factor when it comes to choosing a new GPU.

CHRISTIAN GUYTON

AMD RADEON SOFTWARE
Super-detailed monitoring and tweaking; AMD Link is great; solid capture suite.
★★★★☆

NVIDIA GEFORCE EXPERIENCE
Snappy overlay; great capture and editing tools; simple and readable UI.
★★★★☆

Needs OS X 10.7 or later | US$24.95 | magoshare.com

AweClone

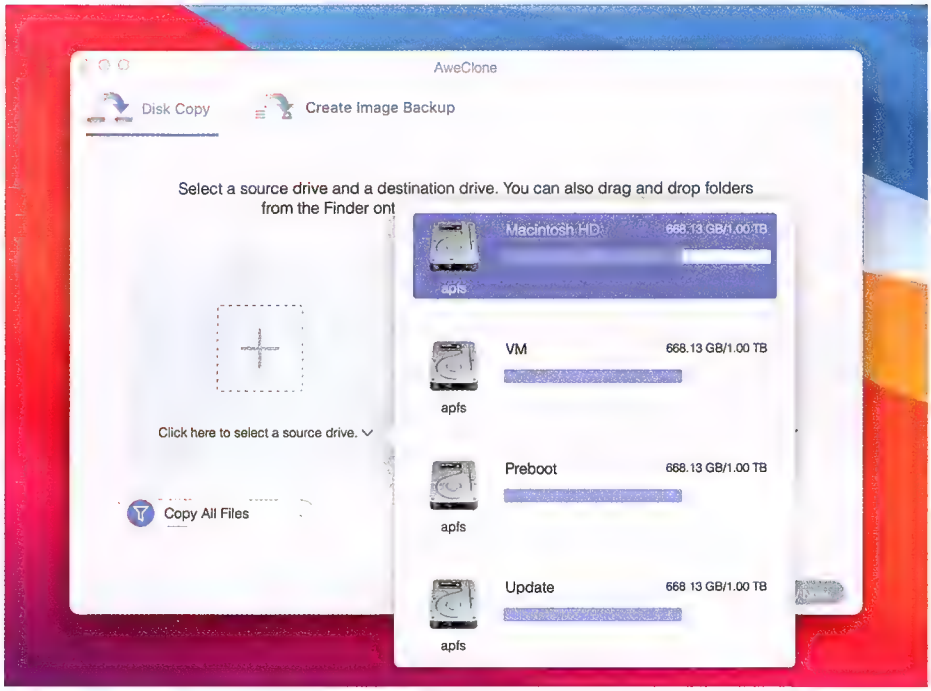
A simple disk copy and backup that doesn't deliver.

Cloning disks and making backups looks deceptively easy, and shouldn't be complex. AweClone is a new contender in a market with well-proven alternatives to bundled utilities such as Disk Utility and Time Machine. It's cheaper and simpler, but how well does it negotiate the bear traps in macOS which have only been growing worse?

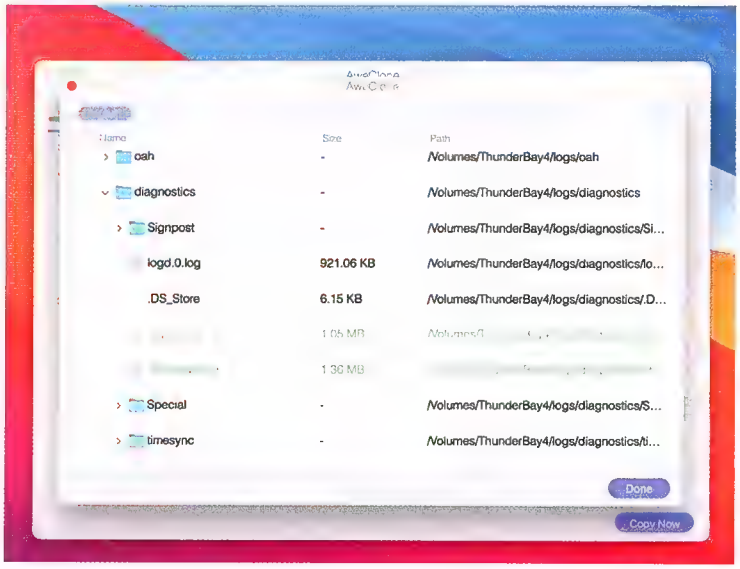
AweClone offers two functions: disk copying and the creation of 'image' backups. As quickly becomes obvious, these aren't anything like cloning and proper backups, though. AweClone makes copies of whole volumes by copying individual files into a folder. This happens fairly quickly, at around 320GB per hour to a regular SSD, but its copy doesn't match the original.

Try this with Big Sur's System and Data volumes, and you end up with a composite in which permissions have all been changed to give you read and write access to each file, as its owner, many of the files and folders are missing from the copy, and it hasn't a clue what to do with a snapshot. The copy isn't formed into a Volume Group, can't be used as a startup disk, and is missing so much it isn't even a faithful backup.

Making 'image' backups works better, but these aren't proper backups, merely one-shot Zip archives or disk images, much as you can create using Disk Utility. There are none of the options offered there, such as encryption or different file systems: AweClone just writes plain HFS+ read-write disk image (DMG) files. It doesn't use these for subsequent incremental backups, nor does it let you schedule them. When you quit the app, any copying task you have set up is lost, so has to be re-entered every time you want to repeat it.



AweClone doesn't grok Big Sur disks, and doesn't show true volume sizes.



When selecting folders to copy or image, its non-standard selector doesn't sort items, but lists them randomly.

Its many quirks are sadly counter-productive. Instead of using a standard file selection dialog, it invents its own which annoyingly lists items in seemingly random order. Its progress bar usually doesn't work, forcing you to rely on a busy spinner which doesn't show progress. Not only does it fail to understand how to work with file systems found in Catalina and Big Sur, it also needs to be added to the Full Disk Access list in Privacy (in the Security & Privacy pane), which passes unmentioned in its sketchy documentation.

If you want to clone or back up volumes, look at the long-proven industry standards Carbon Copy Cloner and SuperDuper! For creating disk images, DropDMG is far more capable. Maybe AweClone will grow into something more useful; for now it just walks into every one of those bear traps waiting for it in recent versions of macOS.

HOWARD OAKLEY

You'll do better with the Finder and Disk Utility.

★★☆☆☆

Needs iOS 13 or later | Free (IAPs) | meetcarrot.com/weather

CARROT Weather

And the outlook is: totally essential.

When it comes to mobile weather apps, CARROT Weather has long been the oddball. Forecasts are laced with snark and sarcasm, presented by malevolent artificial intelligence biding its time as a meteorologist before going all Skynet. When it's about to rain, you'll see a raindrop symbol and a prediction, but you'll also be told it 'sucks to be you' or sagely advice like: 'Don't worry, the rain will wash away the evidence.'

With version 5, though, personality is joined by personalisation – CARROT Weather can be bent to your will through its Interface Maker. You can dive right in, but the app prefers to gradually unlock components, drip-feeding features so it doesn't overwhelm. When it's done, you end up with a range of panels to add, edit, and rearrange. Although several varied presets are also provided.

Whichever path you take, you'll marvel at the possibilities. CARROT Weather can be made to resemble rival apps or the weather app you always wanted.

And the smarts continue. One of the new components is a set of cards that contextually surfaces useful data that's normally buried in other apps. Long-pressing on almost anything provides instant access to details. And quick actions from the tab bar rapidly get you to commonly used features.

The other big change is the price: CARROT Weather now starts off free, but can quickly become expensive. If you opt to not pay, all that stuff about customisation goes out of the window – and you also lose iCloud settings sync, Siri shortcuts, maps, sources beyond Foreca, notifications, Apple Watch complications, and even widgets. That's not to say the free version of CARROT Weather is bad – you still get a compact, usable main view that's dotted with the aforementioned cards, and the only ad banner you'll be happy to see in an app (it either displays a joke or points you at one of the CARROT Weather creator's favourite indie apps). But it is basic fare.

Unlike many iPad weather apps, CARROT can utilise your entire display.

Almost everything in CARROT is a context menu. Long- press a card or hour's/day's forecast for detailed info.

Choose to pay and CARROT Weather's first tier is $0.99 per month – but it's slightly more palatable if you pay annually ($11.49). There's also an Ultra tier (double the cost, adding rain/lightning/storm cell notifications and a few other features) and Family Ultra ($32.99), enabling Ultra use across families.

CARROT Weather's creator has in the past reminded us that data isn't free. Apple and other giants eat data costs or flood weather apps with ads. CARROT Weather wants to be better. To that end, Ultra seems a reasonable ask in its annual incarnation – which you're pushed toward, what with the hefty monthly alternative. And for that you get what's now the most customisable weather app on iPhone, iPod touch or iPad – and, given its capabilities and feature set, also the best.

CRAIG GRANNELL

The funniest weather app is now also simply the best available.

★★★★★

ULTIMATE FIRST LOOK

Windows 11: Everything you need to know

It's been a long wait between new Windows versions, and with Windows 11 now available in beta to Insiders, *APC* with Maurio Hucalak has gone in deep to understand the pros and cons of the OS you'll likely be using before the year is out.

Microsoft recently published the first preview of Windows 11 (Build 22000.51) for devices enrolled in the Dev Channel of the Windows Insider Program, and with it, the company introduced a slew of significant interface changes, features, and updated apps coming this holiday season. Here's a closer look at the new features and changes. We even show you many improvements that Microsoft didn't mention.

In this flight, you will find the new Start menu and a taskbar that both now have a centred alignment and a fresh take on Action Center that includes two experiences: "Notification Center" and "Quick Settings." In addition, there's a preview of the updated version of File Explorer that no longer includes a ribbon menu.

Windows 11 is also introducing a new Widgets feature to consume news and other content, a bunch of multitasking features like Snap layouts and groups, a new Microsoft Store and Get Started apps, a redesigned Settings app with new features and improvements, and a lot more.

In this Windows 11 guide, we will dive deep into the new interface changes, improvements, and new features that Microsoft has made available with Build 22000.51. These are the most important features, improvements, and changes to the user interface that Microsoft has been working on for Windows 11 so far.

System
LABPCW11
Rename
Windows Update
Microsoft 365
OneDrive
Display
Sound
Notifications
Focus assist
Power
Storage
Bluetooth & devices
Network & internet
Personalization
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
ENG
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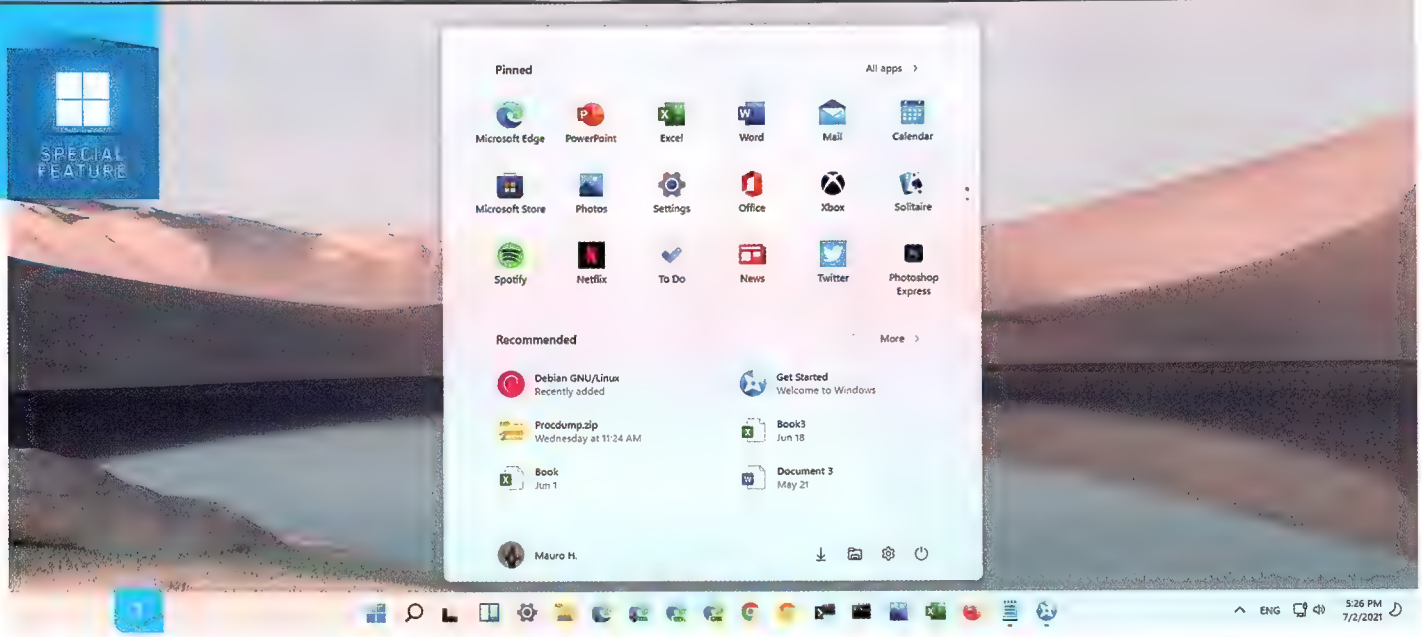


Start menu

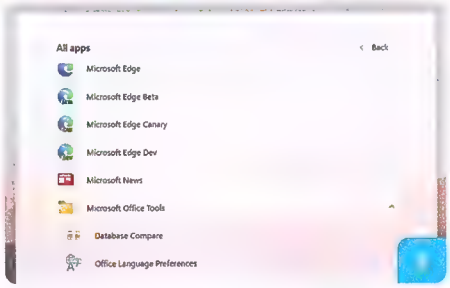
Windows 11 Build 22000.51 introduces a new Start menu design similar to the one the company was building for Windows 10X. The new menu and the updated taskbar appear centred on the screen, and it ditches the Live Tiles for traditional icons. [1]

The **Start menu** has three sections. The "Pinned" section is at the top, and it includes quick access to your favourite apps. You can right-click any app to access the context menu with different options, including moving the item to the top, opening the file location, and uninstalling the app. It's also possible to drag the icons around to change their position. [2]

The default layout includes three rows and eight columns, but you are not limited to only 24 items. You can pin as many apps as you want since you can scroll down to jump to different pages. You can also use the dots on the right side to jump between pages.

You will find the **All apps** button to access the list of all installed applications in the top-right corner. This part is where you will find the "most used" and "recently added" lists. Like in previous versions, you can use the dial to jump to different sections within the list. [3]

The **Recommended section** is where you will find cloud-powered recommendations to files you may want to pick up where you left off and apps.



You can right-click the header to refresh the content, and you can click the More button to access even more recommendations. However, during the time I spent with this build, these options appear and disappeared without warnings.

If you see an item, you don't want. You can right-click and select the option to remove it from the page. [4]

In this version, it is no longer possible to resize the menu, use it in full-screen mode, or create groups. Also, the experience comes with many promoted apps, which you may not be able to differentiate between your own apps and may cause to install apps you don't need.

Then at the bottom, you will find the section that includes the profile menu and power options. The empty space in the middle is where you can place quick access to different folders, such as File Explorer, Settings, Documents, etc.

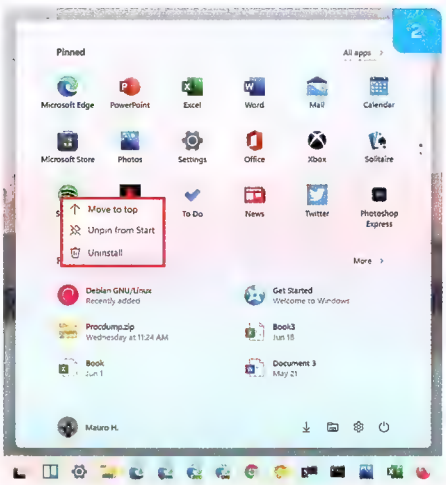
Taskbar, Notification Center, Quick Settings

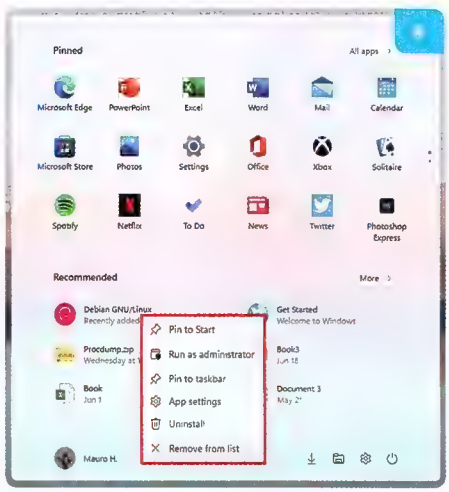
The new **taskbar** also includes a centred alignment, but you can always configure it to the left like in previous versions.

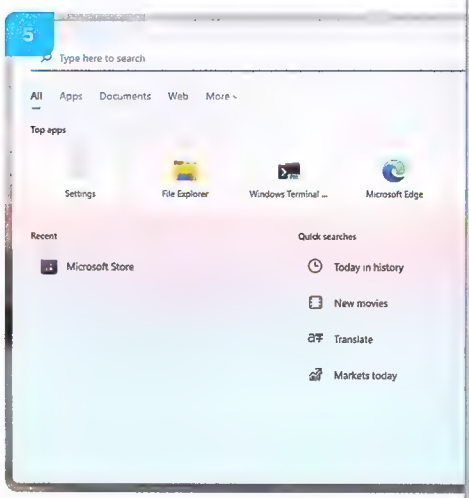
The bar is a little taller than before and includes a lot of improvements. For example, in addition to having all the items aligned in the middle, you will notice a new Start logo, new icons for Search, Task View, and Widgets (Cortana and My People are no longer part of the experience).

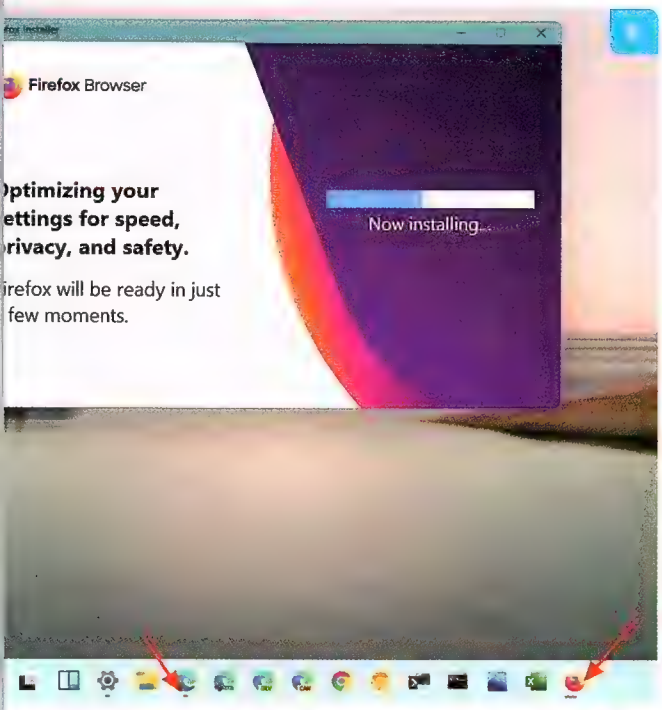
When you hover over some of these icons, a new jump list menu will appear with some recent items or a quick view of the feature. Open apps will show thumbnails just like before.

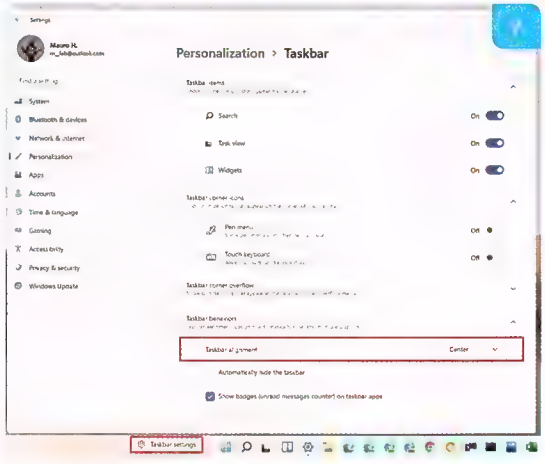
Since there is a new Search button, the search box is no longer a feature in the taskbar. Also, the Search experience has been updated with a search box located at the top. And you will no longer find "Timeline" as the feature has











been stripped out of the OS. [5]

There's a new small indicator that changes size for running applications to distinguish whether the app is minimised or maximised. And there is a new progress indicator for installing applications. [6]

In Windows 11, you cannot resize the taskbar nor change the location to either top, left, or right. The only supported position is at the bottom. It's possible to show the taskbar across monitors, but you cannot show the Start menu and other items from the primary menu across all displays.

The taskbar context menu has also been reworked, and it now only includes an option to open the Taskbar settings page. In the settings for the taskbar, you can add or remove items, control the icons that appear in the corner and the apps that appear in the overflow menu. [7]

In the "Taskbar behaviours" section, you'll find the options to change the taskbar alignment, hide the bar automatically, and show badges. Also, there is even a new setting to show or hide the desktop using the corner button (Windows key-D keyboard shortcut).

Quick Settings

The taskbar included with Windows 11 Build 22000.51 also introduces a new notification area that now groups icons into an actionable button that brings up the new Quick Settings flyout. This menu includes the most common settings, such as volume, brightness, wireless, Bluetooth, Focus Assist, and others. However, the Tablet mode option has been removed since the company will be making the touch experience only on compatible devices.

If you are playing audio or video with Microsoft Edge, the Quick Settings will also show new media controls above the settings. [8]

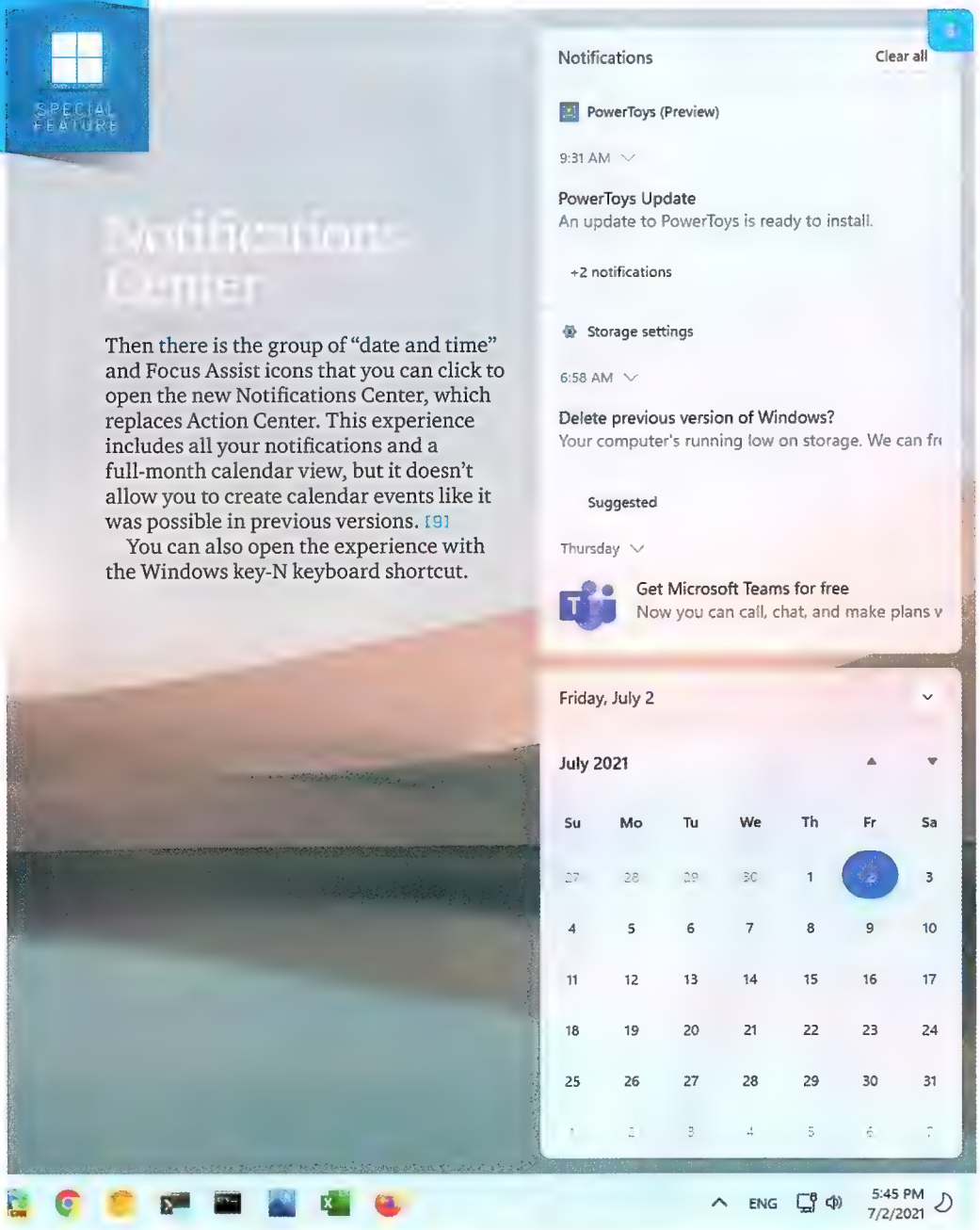
When you right-click the network or volume icons, you can access the network and volume settings. However, you will also notice a Volume mixer option that opens the experience in Settings instead of Control Panel.

You can also open the experience with the Windows key-A keyboard shortcut.

Notifications Center

Then there is the group of "date and time" and Focus Assist icons that you can click to open the new Notifications Center, which replaces Action Center. This experience includes all your notifications and a full-month calendar view, but it doesn't allow you to create calendar events like it was possible in previous versions. [9]

You can also open the experience with the Windows key-N keyboard shortcut.


Notifications
Clear all
PowerToys (Preview)
9:31 AM
PowerToys Update
An update to PowerToys is ready to install.
+2 notifications
Storage settings
6:58 AM
Delete previous version of Windows?
Your computer's running low on storage. We can fr
Suggested
Thursday
Get Microsoft Teams for free
Now you can call, chat, and make plans v
Friday, July 2
July 2021
Su Mo Tu We Th Fr Sa
27 28 29 30 1 2 3
4 5 6 7 8 9 10
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5:45 PM
7/2/2021

Widgets

Widgets in Windows 11 is an experience similar to the 'news and interests' feature already available on Windows 10. It features a bunch of cards with different types of information, such as weather, news, sports, stocks, traffic, and you can even display Microsoft To-Do lists and more. [10]

The experience takes the full height and almost half of the screen, but the company has shown videos expanding the interface across the entire screen. The Widgets interface also includes a search box to look up things on Bing with Microsoft Edge, and it shows the current time. And you can click the profile button or the "Add widgets" button to customise the experience.

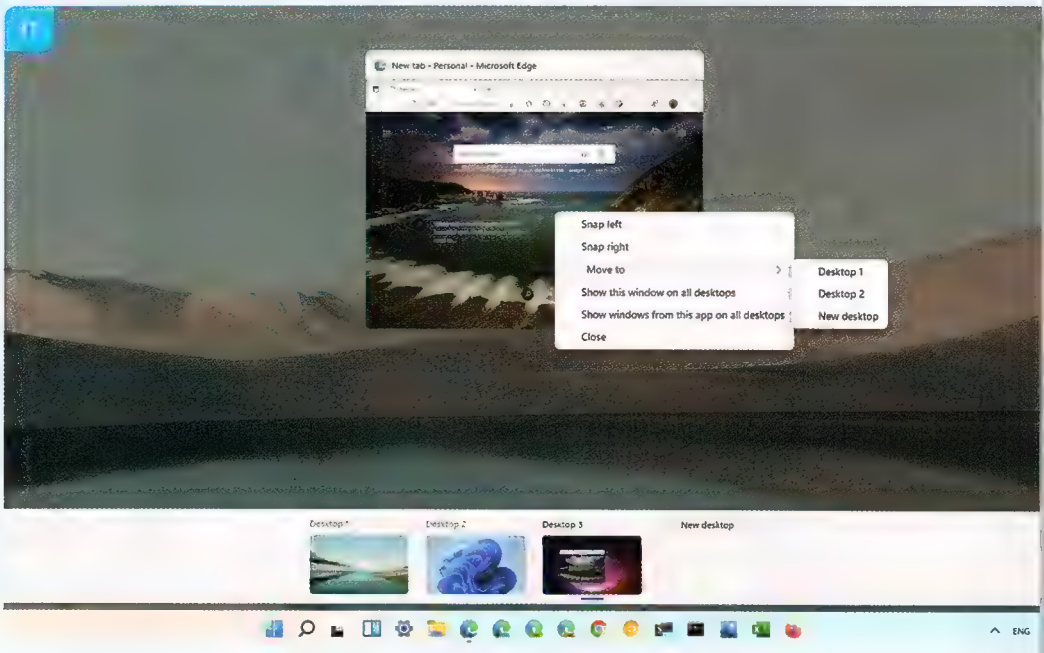
You cannot disable the feature, but you can remove the button from the taskbar settings if you do not want to use it.

Task View and Desktops

The new version of the OS comes with the Task View experience and "Virtual Desktops" feature that has been renamed to Desktops.

You can click the new Task View button or the Windows key-Tab keyboard shortcut to use both experiences. Similar to the previous version, you can view all your running applications and use all the same options as before but with the difference that Timeline is no longer part of the experience, and the controls are at the bottom of the interface. [11]

In the new experience, you can reorganise, create, and customise as many virtual desktops as you need, and each one can have a different background. Also, hovering over the Task View button will now show a preview of all the desktops.



Multitasking

Another big focus of Windows 11 is improving the multitasking experience. And Build 22000.51 ships with at least four significant improvements, including Snap layouts, Snap groups, and changes for managing multiple monitors.

Snap layouts is a new feature part of the Snap assist experience that brings a menu with different grids, which you can use to snap windows on the screen by hovering over the maximise button. Once you select a snap layout and position, Snap assist will guide you to continue positioning windows in the remaining zones. Depending on the size of the screen, you may see four or six different grids. [12]

Also, if you are snapping in portrait mode, when snapping to the right and left, Snap Assist will snap the apps to the bottom and top as you rotate the screen.

Furthermore, when dragging windows manually to any of the corners or sides of the screen to snap the window, you will now see a new visual with transparent elements previewing how the windows will snap in place.

While you have been able to snap windows for a long time, Snap layouts will come in handy to help users manage windows, and thanks to the new layouts, it will make it easier to manage windows in wider displays.

You can also invoke the Snap layouts using the Windows key-Z keyboard shortcut.

"Snap groups" is a feature that is part of the taskbar experience that lets you switch back to different groups of snapped windows when switching to another app, so you do not have to re-snap them again to get back to what you were doing faster. [13]

These features are enabled by default, but you can disable them from the Multitasking settings page.

Windows 11 Build 22000.51 also comes with new settings to make it ease the pain using an external monitor with your laptop. For instance, when you disconnect the external monitor, all the running applications on the external display will minimize automatically. Then when you reconnect the monitor, the system will restore all the apps to their original location.

The feature comes enabled by default, but you can manage this experience from Settings > Display > Scale & layout > Multiple displays. The settings include:

- Remember window locations based on monitor connection.
- Minimise windows when a monitor is disconnected.
- File Explorer

Microsoft is also working on a new version of the File Explorer app, and even though it does not come with support for tabs, it comes with the same legacy look but with a modern interface.

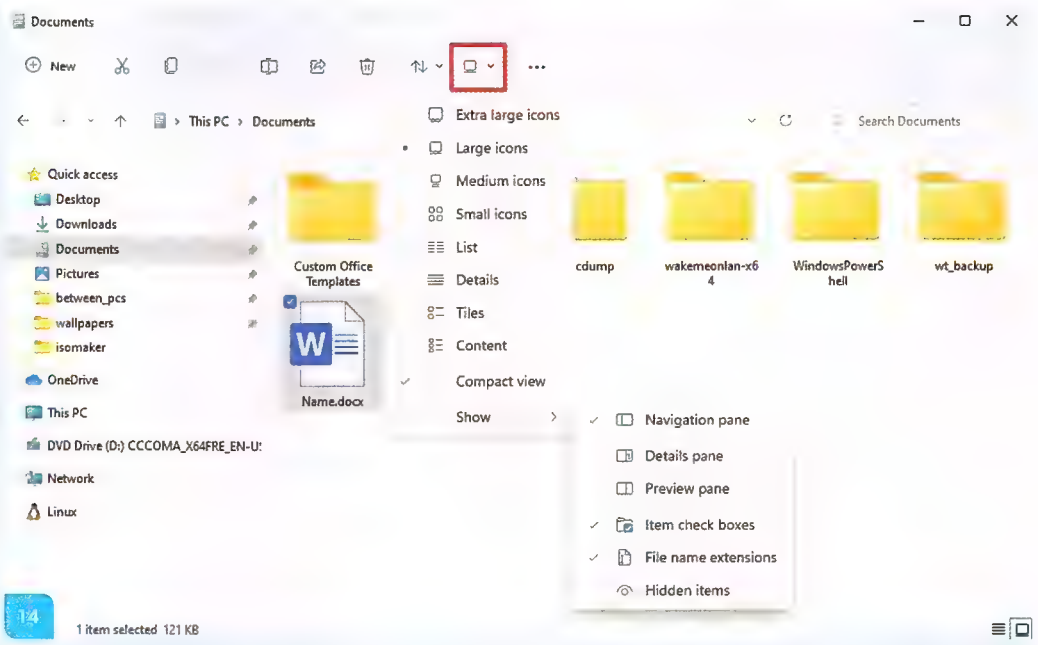
In this new version, the ribbon-style menu is gone, and it has been replaced with a new menu with new icons (without labels) for basic commands, including copy, paste, rename, share, and recycle. And now, the menu and the title bar are combined into a single element with semi-transparent visuals.

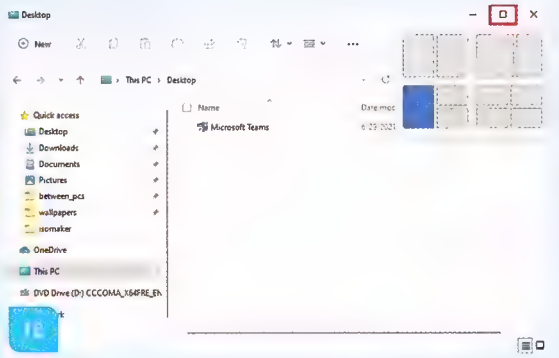
Also, you will find a "New" button that opens a menu with options to create folders and different items like Shortcut, Compressed Folder, Text Document, etc.

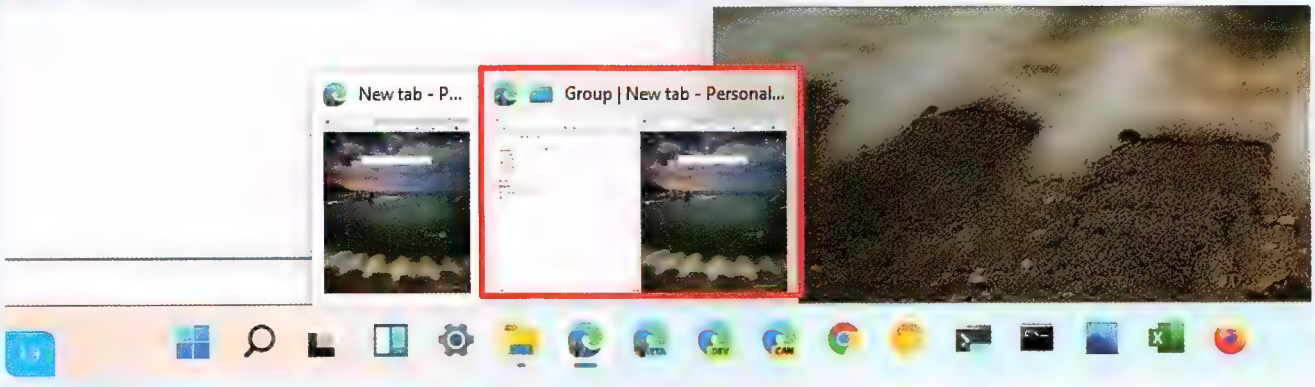
Since there is no more ribbon with tabs, the new Explorer is accommodating the other tabs command in three new drop-down menus, including "Sort and group options," "Layout and view options," and "See more." [13]

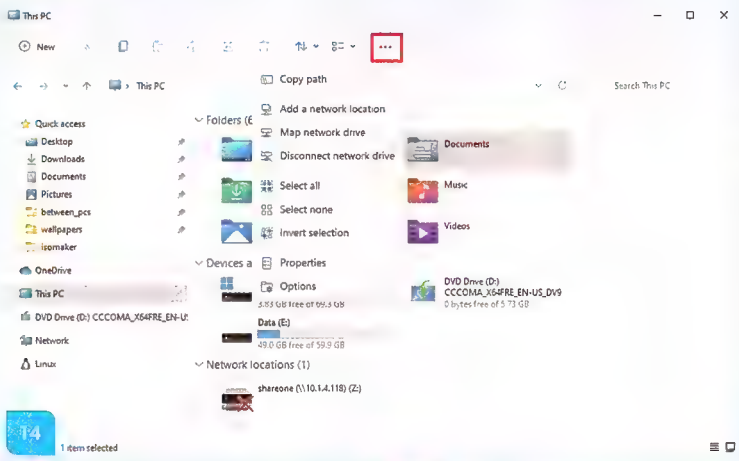
In the Sort and group options menu that's where you will find the options to sort content by name, date modified, type, and more.

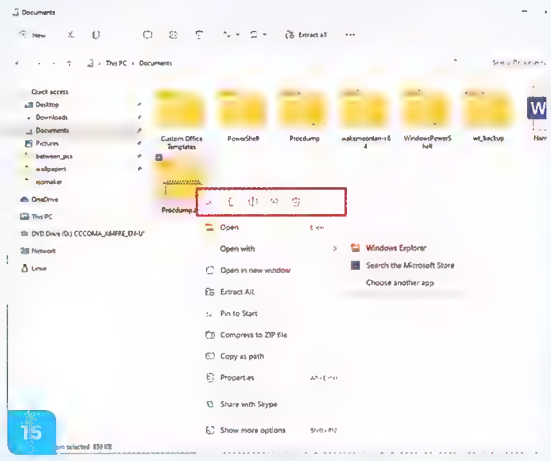
The Layout and view options menu is the place to find the options to show items in different sizes, such as extra-large, large, small, list, details, and more. The menu also











includes the option to enable the compact view instead of the new view with more padding.

In addition, the Show submenu also includes the options to manage the left pane view, show or hide extensions, or hidden items.

Finally, the See more (three-dotted) menu houses the commands for selections, compressed to ZIP file, and Options to manage the app settings.

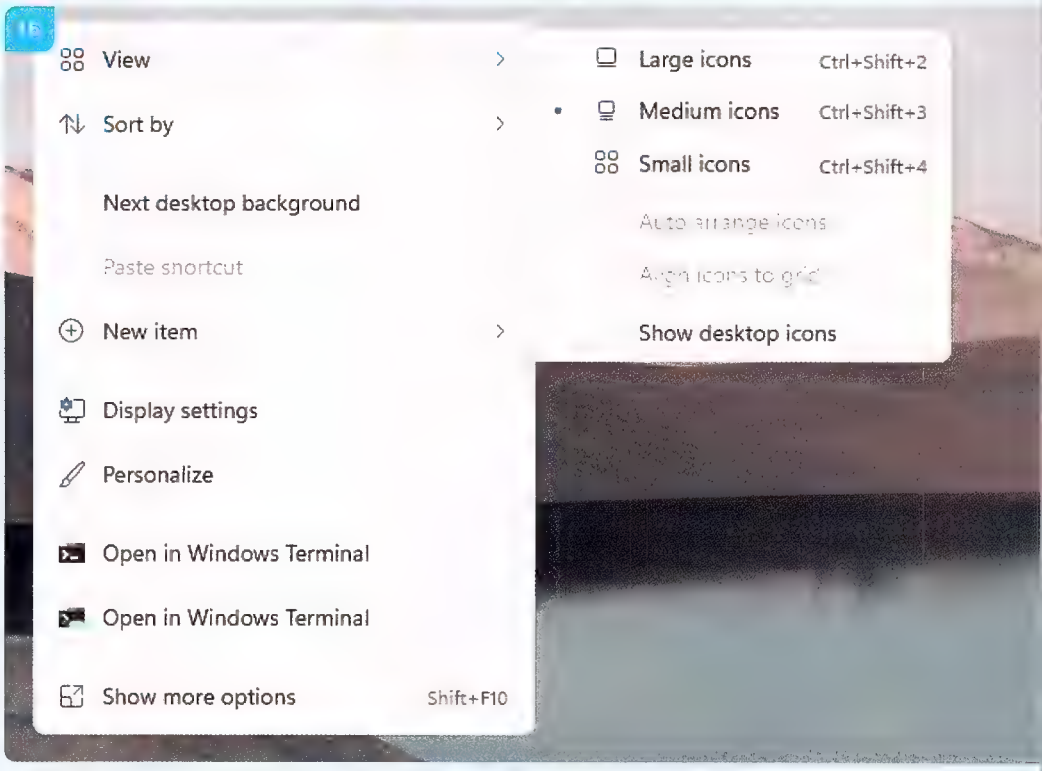
Similar to the ribbon menu experience, the options in the new modern menu will adapt to the content, meaning that depending on where you are and the files you are managing, you will see different settings. For example, the "New" menu will not show the option to create a new folder if you in the "This PC" page. However, the "See more" menu will include the options to manage network locations and map network drives. [14]

If you view a zip folder or select an image, you will see different options in the menu.

The File Explorer on Windows 11 also comes with a new context menu. When you right-click an item, you will see the new menu that includes a first row with commands for quick access to cut, copy, rename, share, and recycle, and the rest of the items will be different depending on the items you are selecting. [15]

The new context menu implements a new interface with rounded corners, more padding between items, and simple and consistent iconography for each action.

If you like the more traditional menu, you can select the Show more options item (or Shift key-F10 keyboard shortcut), and that will open the classic menu.

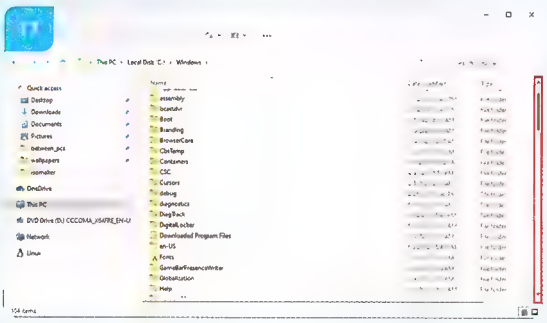


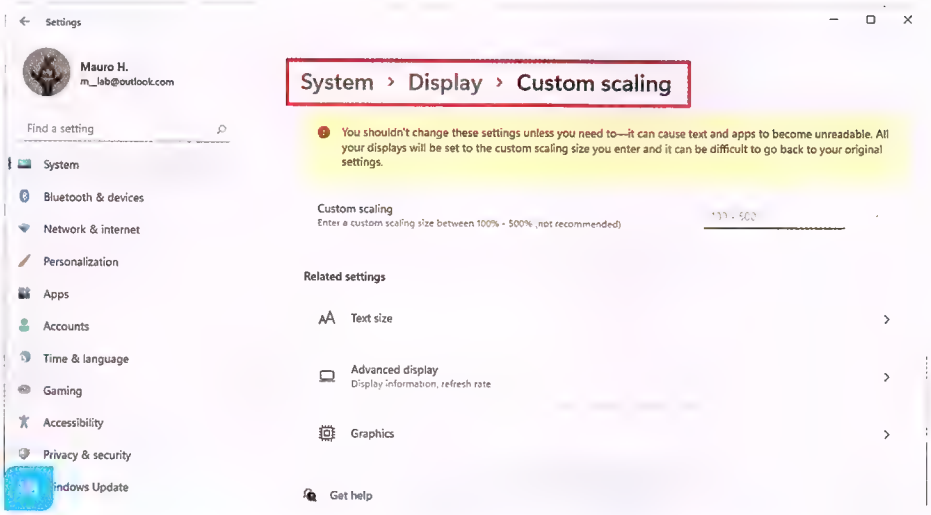
The new context menu style is available in File Explorer, Desktop, and across the experience. [16]

Then there is also the new scrollbar, which is more minimalistic, and it's the new design you will see across all the remaining legacy elements. [17]

Aside from the new menu, which is basically the entire design, plus some other tweaks, the new app still a work in progress since a lot of parts, such as the recent locations menu, Folder Options settings, This PC, driver properties, and format tool continues to use the legacy interface, and the dark mode doesn't work correctly.

It's early to judge the experience, but in my opinion, the new design might impact productivity. For example, if you relied on the ribbon menu, it will take more steps to create a folder, and since there are no labels, it could be easy to get confused with the new buttons (for example, copy, paste, and rename).




Settings
Mauro H.
m_lab@outlook.com
Find a setting
System
Bluetooth & devices
Network & internet
Personalization
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
System › Display › Custom scaling
You shouldn't change these settings unless you need to—it can cause text and apps to become unreadable. All your displays will be set to the custom scaling size you enter and it can be difficult to go back to your original settings.
Custom scaling
Enter a custom scaling size between 100% - 500% (not recommended)
Related settings
Text size
Advanced display
Display information, refresh rate
Graphics
Get help

Settings app

Windows 11 Build 22000.51 also comes with a brand-new Settings app. The app features a new interface using the new Mica material for the frame, rounded corners, and new colourful icons. And all the settings follow the same organisation as it was on Windows 10, but now they grouped differently.

As you open the app for the first time, you still have the left pane for navigation, but it no longer features a main page like the legacy version. Instead, you are taken to the "System" page.

When you navigate the settings, you will notice the breadcrumbs that let you know where you are as you go deep into the settings. You can also click each breadcrumb to jump between pages. [19]

Pages can also have hero controls that highlight specific features and frequently used settings, which can change as you modify the system configuration. For example, the System page includes a screen icon representing the system with the current background preview, computer name, and an option to rename the system.

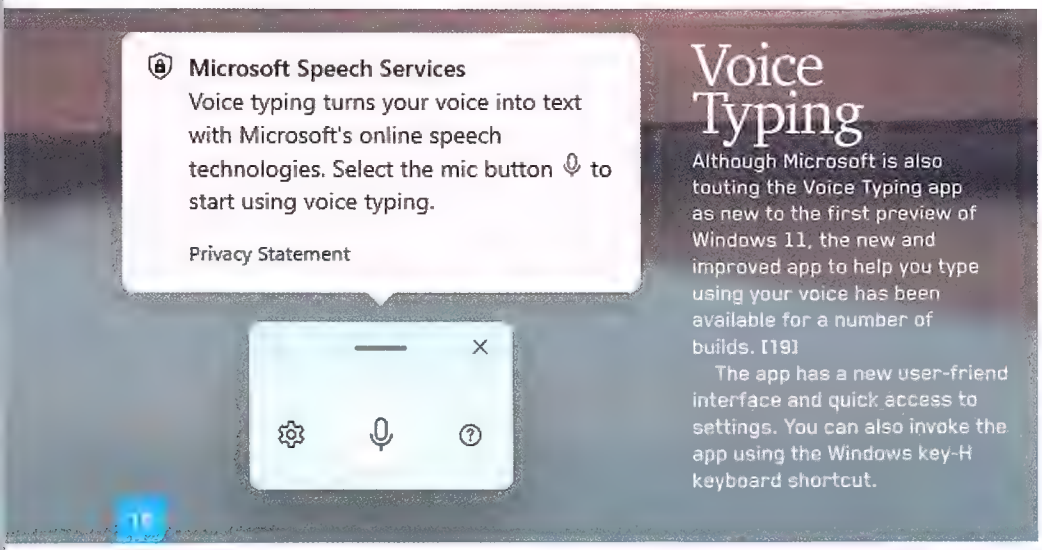
Then at the left, you will find the status for Windows Update, OneDrive, and Microsoft 365.

Inside each of the sections, you will find a list of pages with related settings. The settings organisation has a similar structure as the experience available on Microsoft Edge, where you click the page name to access the settings. Inside the pages, you may find more pages or different sections to customize the experience.

The navigation pane on the right is now at the bottom, and the links to other related settings now appear as buttons to match the style design of the app.

The Settings app will also be able to recommend settings based on your current configuration. For instance, if the device is set to never sleep, you may find a recommendation explaining that the feature is disabled, and enabling it could help to save battery.

Since the settings are virtually the same as ones for Windows 10, we will highlight only the interesting changes.


Microsoft Speech Services
Voice typing turns your voice into text with Microsoft's online speech technologies. Select the mic button to start using voice typing.
Privacy Statement

Voice Typing

Although Microsoft is also touting the Voice Typing app as new to the first preview of Windows 11, the new and improved app to help you type using your voice has been available for a number of builds. [19]

The app has a new user-friend interface and quick access to settings. You can also invoke the app using the Windows key-H keyboard shortcut.

Windows Ink is now Pen menu

In this flight, Build 22000.51 is also renaming "Windows Ink Workspace" to "Pen menu," and the experience has been redesigned to now let you pin any app you want.

Font

As part of the system overhaul, the new Segoe UI Variable font family that features changes to scale the font seamlessly from small to larger display sizes is fully implemented. This new font is based on the legacy Segoe with new improvements for better legibility at small sizes and better outlines at display sizes.

Animations

Windows 11 also introduces new animations to make the system feel snappier and more comfortable using. You will notice these animations as you slide features in and out, snap or resize windows, open apps from the taskbar, and click or remove buttons from the taskbar.

There is even a new loading animation for installing apps or updates.

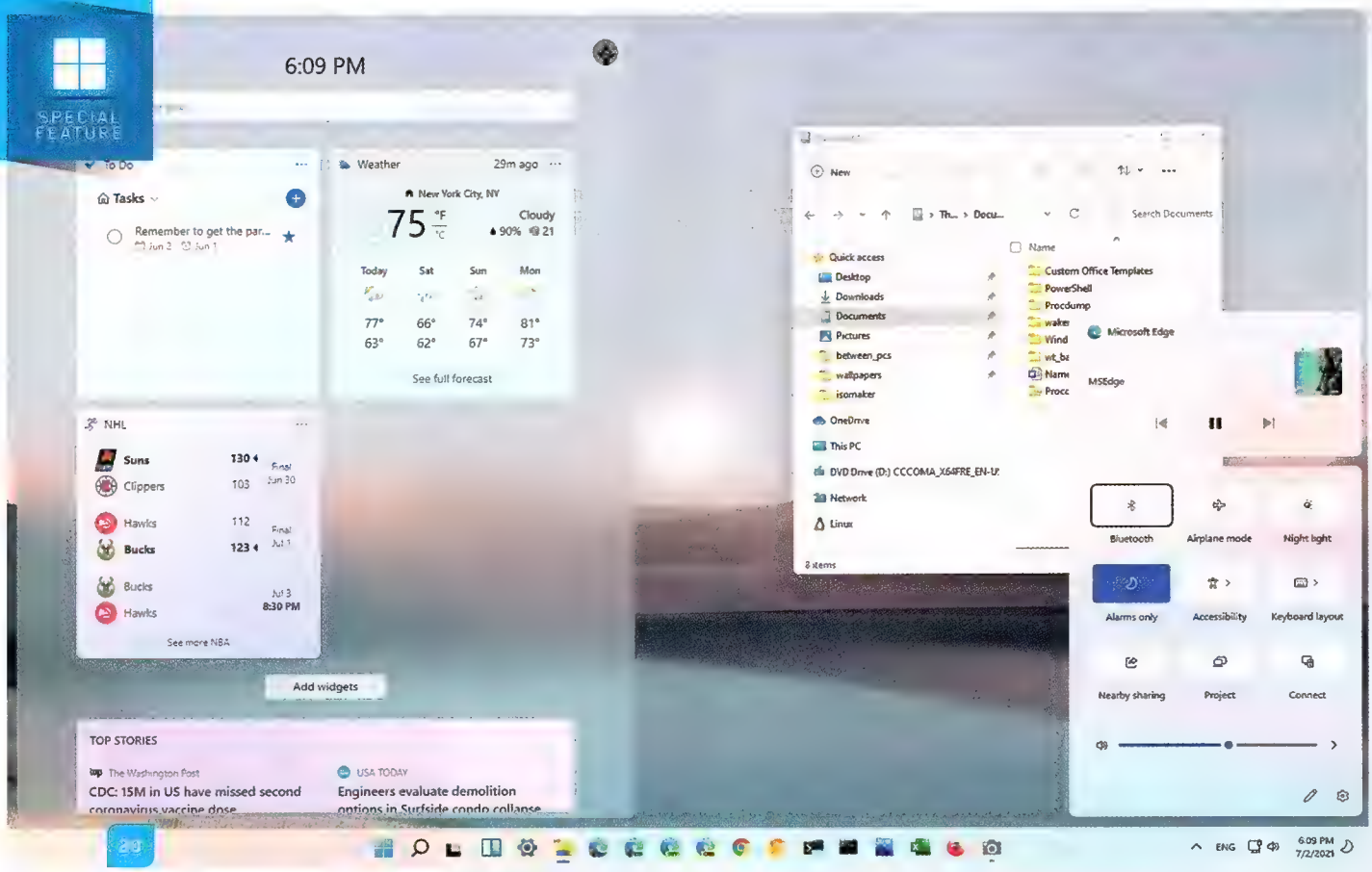
Sounds

This is a big deal for many users. The startup sound is back, and it has a new melody. In addition, almost all the sounds for common actions have been replaced with new sounds designed to be a little more atmospheric and lighter. You will also find that the sounds will be slightly different depending on whether you are using the dark or light mode.

Lock screen and Sign-In screen

You are also getting a preview of the new Lock screen. The experience looks similar to the previous version, but it now centres the time and date information on the screen like on your mobile phone.

The Sign-In screen looks exactly like the one on Windows 10, but it now includes new iconography for bottoms available in the bottom-right corner. Also, the text box to enter the password or PIN now has a coloured underline (you will see this virtually in any text box across the experience).



General UI and sounds

Windows 11 is all about the rounded corners. You will find this design style across all the elements, including frames, buttons, flyout interfaces, menus like context menu, Start menu, taskbar, Notifications Center, and Quick Settings.

Microsoft is also implementing new design materials, including Mica and Acrylic. Mica is a new material that will let the desktop pass through the application frame and indicate that the window focuses on whether you are using the dark or light mode. [20]

According to the company, the Mica material is a very performant visual effect, it will save battery life, and psychologically the rounded geometry for corners provides a feeling of safety and makes the app's interface much easier to scan.

Then there is the Acrylic material that creates a more translucent physical texture, and you will see this effect more when using Snap Assist, Widgets, other features.

In addition to the new material, starting with Build 22000.51, the OS is also getting a new dialog box with a more straightforward design matching the Windows 11 design style with a white background and buttons that match the system colour accent.

System

In the System section that's where you find the options to configure the Display, Sound, Notifications, Focus assist, Power, Storage, Nearby sharing, Multitasking, Activation, Troubleshoot, Recovery, Projecting to this PC, Remote Desktop, Clipboard, and About.

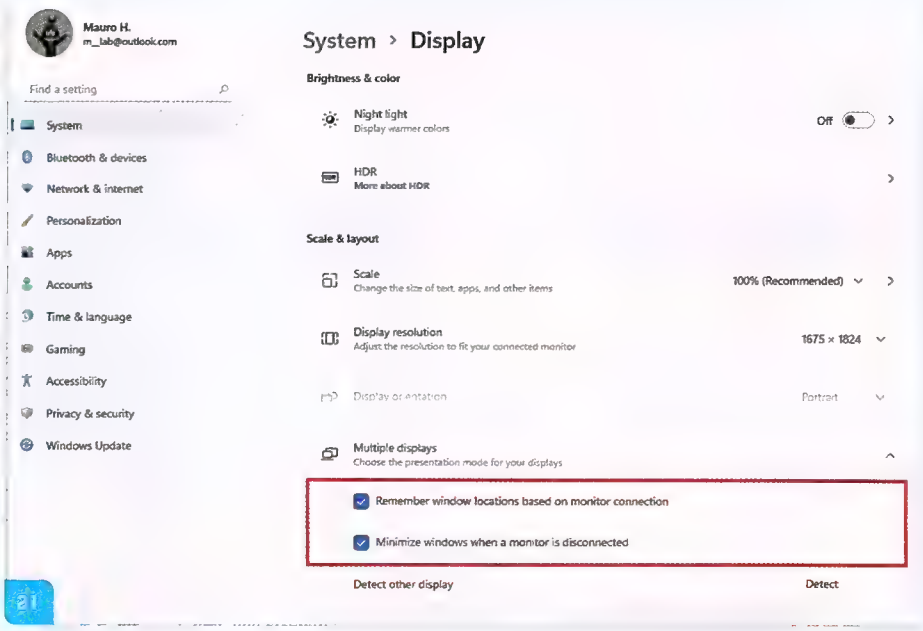
The hero controls in this section include an icon representing the device with the current background preview, computer name, and an option to rename the system. Then at the left, you will find the status for Windows Update, OneDrive, and Microsoft 365.

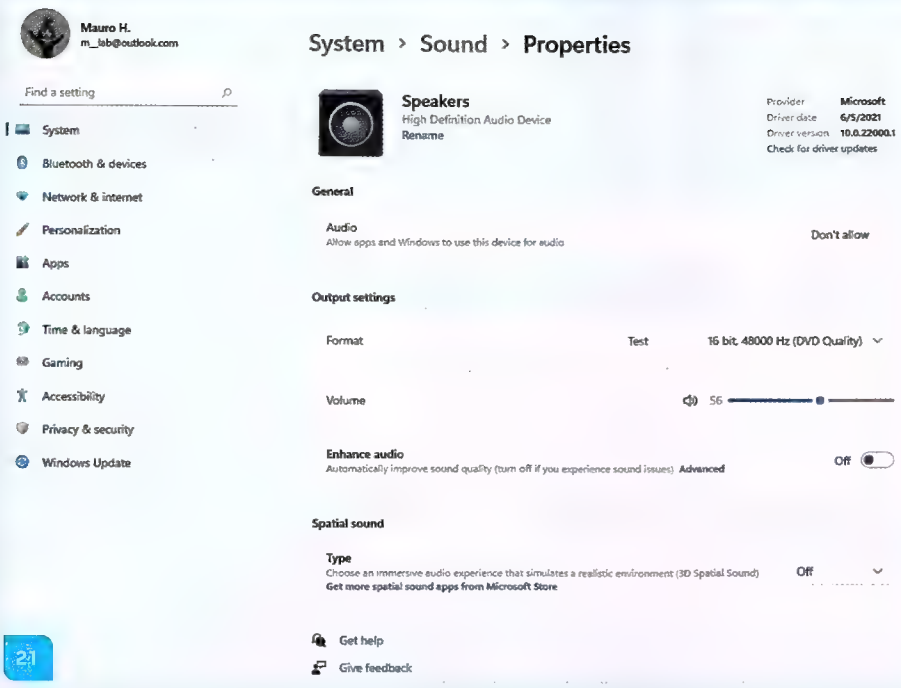
On System > Display, the Scale & layout section has been updated with new Multiple displays settings, including:

- Remember window locations based on monitor connection.
- Minimise windows when a monitor is disconnected. [21]

As previously described, using these settings when you disconnect the external monitor, all the apps will minimise in the taskbar. Then when you reconnect the monitor, the system will restore all the apps to their original location.

On System > Display, in the Advanced display page, there is an option (Dynamic) to configure the new Dynamic Refresh Rate (DRR) feature that allows Windows 11 to automatically lower or increase the display





refresh rate to reduce the power consumption.

The option will be available only for a laptop or device with a display of 120Hz refresh rate that also meets other requirements.

On System > Sound, in the Properties page for input or output devices, the experience has been redesigned with high-quality icons for the peripheral, driver information, and settings previously only available using Control Panel.

For example, the properties page for the speakers includes permission options, the ability to choose the audio format, and other audio-specific settings. [22]

In the Sound page, the Output section also includes an option to combine the left and right audio to produce mono sound, and there are options to pair new output and input devices using Bluetooth or other connections.

At the bottom of the page, Windows 11 Build 22000.51 includes an option to access the "All sounds devices" to turn devices on or off, troubleshoot, and find other options.

In this flight, the "App volume and devices preferences" page has been renamed to "Volume mixer." It includes all the same settings, and it replaces the legacy mixer menu available in the taskbar.

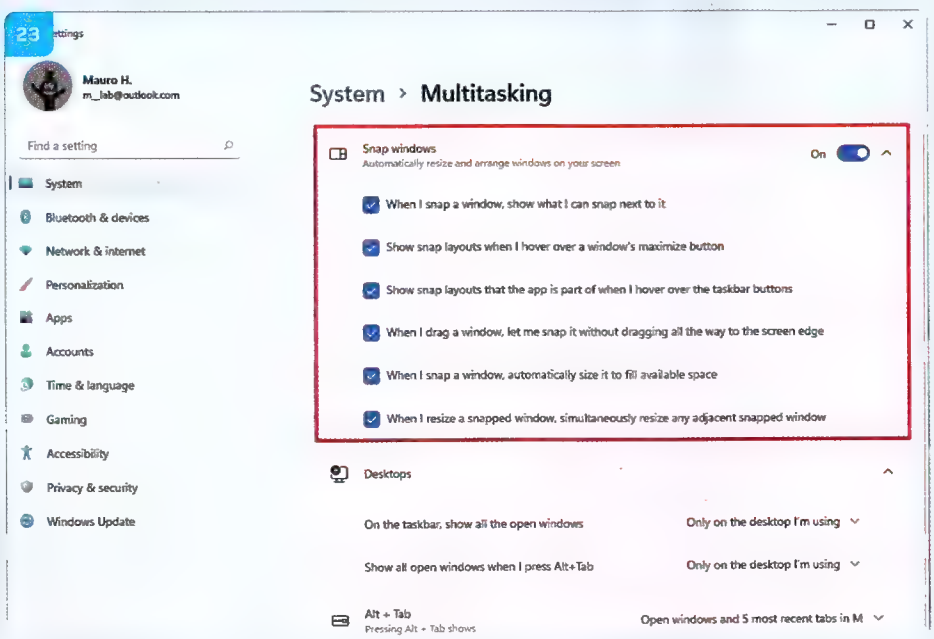
On System > Multitasking, the "Snap windows" section has been updated with two more features to enable or disable Snap layouts and Snap groups:

- Show snap layouts when I hover over a window's maximise button.
- Show snap layouts that the app is part of when I hover over the taskbar buttons.

And then there's a new option: When I drag a window, let me snap it without dragging all the way to the screen edge.

The "Show suggestions in your timeline" is no longer available since Timeline is no longer a feature on Windows 11. [23]

The "Virtual Desktops" settings have been renamed to "Desktops." The section includes all the same settings as before.


Settings
Mauro H.
m_lab@outlook.com
Find a setting
System
Bluetooth & devices
Network & internet
Personalization
Apps
Accounts
Time & language
Gaming
Accessibility
Privacy & security
Windows Update
System › Multitasking
Snap windows
Automatically resize and arrange windows on your screen
On
When I snap a window, show what I can snap next to it
Show snap layouts when I hover over a window's maximize button
Show snap layouts that the app is part of when I hover over the taskbar buttons
When I drag a window, let me snap it without dragging all the way to the screen edge
When I snap a window, automatically size it to fill available space
When I resize a snapped window, simultaneously resize any adjacent snapped window
Desktops
On the taskbar, show all the open windows
Only on the desktop I'm using
Show all open windows when I press Alt+Tab
Only on the desktop I'm using
Alt + Tab
Pressing Alt + Tab shows
Open windows and 5 most recent tabs in M

Bluetooth & devices

The Bluetooth & devices section only includes a giant button to bring up the setup to add new devices for hero controls, and it houses the pages to customize Bluetooth, Devices, Printers & scanners, Your Phone, Cameras, Mouse, Touch, Pen & Windows Ink, AutoPlay, and USB.

Starting with Build 22000.51 to see all your devices, you need to click the "View more devices" option or click on "Devices," which also happens to include an "Add device" button to install a new device quickly.

While all the pages were available in previous builds, there is a new Touch page that appears even when you don't have a touch-enabled display, and it houses the options to control touch features.

Also, as part of the gesture improvements, this preview includes new touch gestures to make it easier to switch between apps and desktops. These gestures are similar to the ones you would use on a touchpad, including:

Three-finger gestures on Windows 11:

- Swiping left or right to switch to the last used app.
- Swiping down go back to the desktop.
- Swiping up to open Task View.

Four-finger gestures:

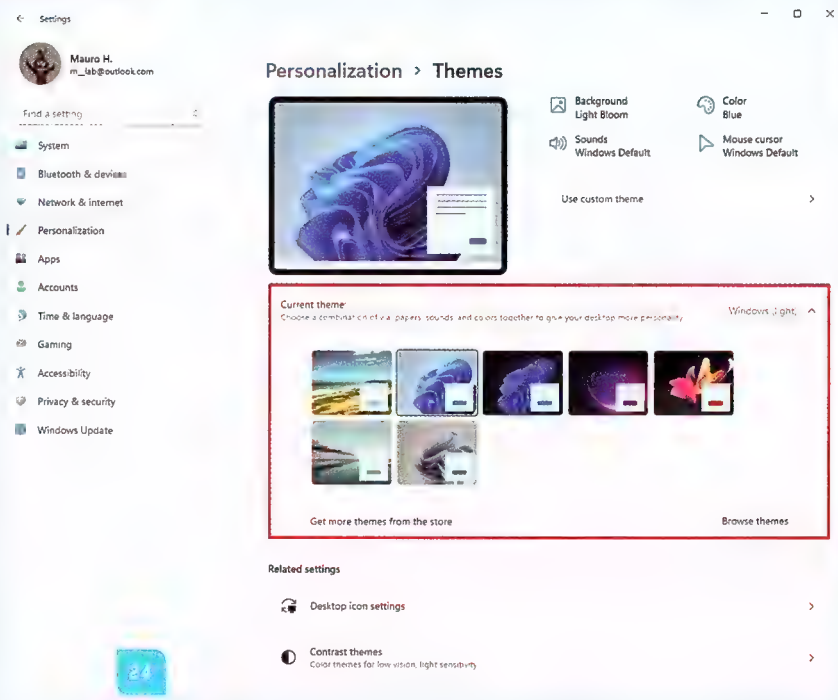
- Swiping left or right to switch to the previous or next desktop.
- Swiping up or down go back to the desktop.

Network & internet

In the Network & internet section, you will find the active network connection, access to the properties for the active network connection, and data usage information as hero controls. This section includes the settings for Ethernet, Wi-Fi, VPN, Mobile hotspot, Airplane mode, Proxy, Dial-up, and Advanced network settings.

On Network & internet > Wi-Fi, the page includes all the same settings as before, but now you can view the available networks without opening the network flyout.

On Network & internet > Advanced network settings, this page is new, and it allows you to enable or disable network adapters without having to access the Control Panel.



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Personalisation

In the Personalisation section, you will find a preview of the current theme and the options to choose between the six new default themes as hero controls. This section includes the settings for Background, Colours, Themes, Lock screen, Touch keyboard, Start, Taskbar, Fonts, and Device usage.

On Personalisation > Themes, the page only includes the six new themes for Windows 11. [24]

On Personalisation > Touch Keyboard, this page is new, and it includes the options to change the sizes of the keyboard. Also, you will find 12 themes you can use to customise the touch keyboard. Furthermore, there's an option at the bottom that lets you customise the theme with custom colours.

Other options include the ability to enable or disable the key backgrounds, select the key text size, and option to preview the changes.

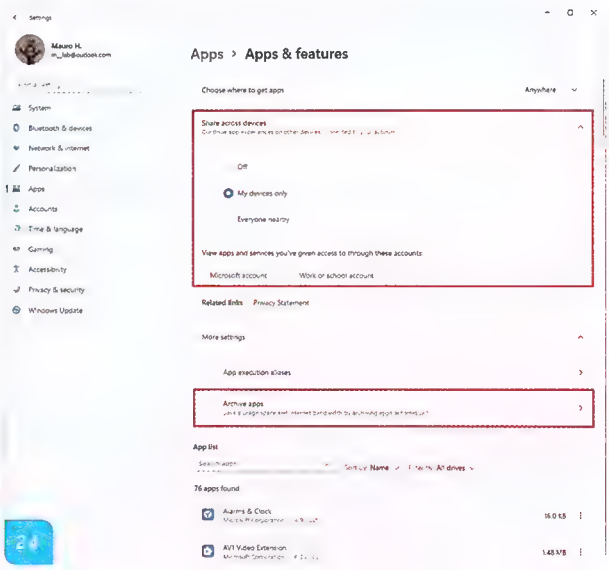
On Personalisation > Start, the page has been updated to reflect the settings for the new Start menu. As a result, a lot of the legacy settings have been removed, and you can only show or hide recently added apps, most used apps, and jump list items.

The "Folders" option lets you choose what folders (Settings, File Explorer, Documents, etc.) appear next to the power button in the Start menu.

On Personalisation > Taskbar, the page has been updated to house all the settings corresponding to the new taskbar. Similar to the Start settings, many legacy options have been removed, including the ability to change the taskbar location, show small icons, and other options.

The page is divided into three sections, including Taskbar icons that let you add or remove the Search, Task View, and Widgets buttons. The Taskbar corner icons section includes options to add or remove the Pen menu and Touch keyboard buttons in the taskbar's notification area. The Taskbar corner overflow section lets you show or hide icons that appear in the taskbar corner overflow menu.

The Taskbar behaviours section includes the settings to change the taskbar and Start menu alignment to the left or centre. Also, you get the options to hide the taskbar automatically, show badges for apps, show the taskbar across all the displays, and there is a new option to enable or disable the show desktop button in the far corner.



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Apps

The Apps section doesn't have hero controls, and it is the place to find the Apps & features, Default, Offline maps, Optional features, Apps for websites, Video playback, and Startup pages.

On Apps > Apps & features, the page includes a new Share across devices feature, allowing you to continue the app experience across your devices connected with a Microsoft account. You can choose to disable the feature or set it only to share the experience with your devices or any device nearby. [24]

You will also find "Archive apps" under the "More settings" section. The feature is meant to save storage and internet bandwidth by archiving those apps from the Microsoft Store you don't use frequently. Then the next time you use the app, it'll download automatically from the Store. The feature isn't entirely new. It was previously available in Insider builds, but the company is now bringing it back with Build 22000.51.

On Apps > Optional features, this page was previously under Apps & features but now is part of the "Apps" section. Other than moving the page forward, everything is still the same.

Windows 11 apps

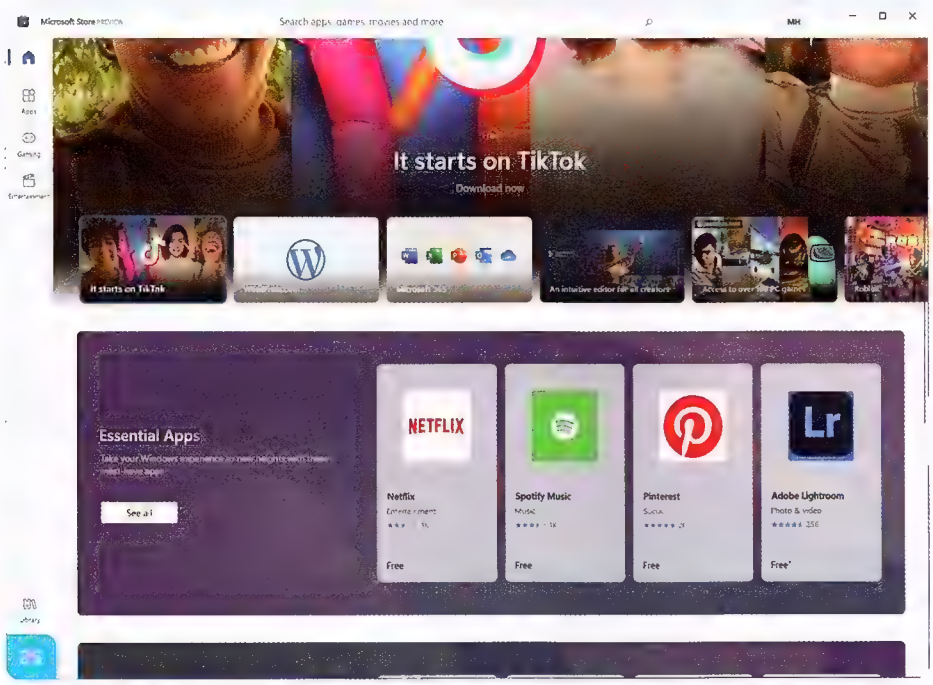
In addition to the new features and changes, Windows 11 Build 22000.51 also introduces a couple of new applications, including a new Get Started and Microsoft Store apps.

Get Started

The Get Started app still a work in progress, and it appears that Windows 11 will ship with an app to help users get started. However, the app promotes only OneDrive, Microsoft Edge, and the Your Phone apps at the time of this writing.

Accessibility

The Accessibility section includes the settings for Text size, Visual effects, Mouse pointer and touch, Text cursor, Magnifier, Colour filter, Contrast themes, Narrator, Audio, Captions, Speech, Keyboard, Mouse, and Eye control. On Accessibility > Visual effects, this page is new, but the settings were previously available in the "Display" page, which is no longer available starting with Windows 11 Build 22000.51. [25]



Microsoft Store

Starting with Build 22000.51, Microsoft is making available the first preview of the new Microsoft Store. The new experience does not come built into the OS, but it's available through an app update. Once you received the new version, you notice a redesigned experience using rounded corners, a search box front and centre, and a left navigation pane to the browser between the different categories, including home, apps, gaming, entertainment, and library. [26]

Perhaps one of the most significant changes for users is that the Store will now host virtually any type of apps, including traditional win32, Universal Windows Platform (UWP), Progressive Web Apps (PWAs), Xamarin, Electron, React Native, and Java apps.

Furthermore, Microsoft is bringing more big names in apps, including Adobe Creative Cloud, Disney+, TikTok, Zoom, Microsoft Teams, Visual Studio, and even Notepad and Paint.

According to the company, the new Microsoft Store has been redesigned to make more space for content, keeping the experience responsive and straightforward. There's a new layout to view apps with bigger screenshots, descriptions, and ratings. Also, when clicking the "Install" button, the downloading and installing visuals are similar to the Apple App Store.

Microsoft is also introducing policies changes to allow developers to implement their own third-party commerce platform for their apps, allowing developers to keep all the revenue. For those who rely on the Microsoft Commerce platform, the solution will continue to exist with revenue share at 85/15 for apps and 88/12 for games.

Windows 11 will also support Android apps through the Microsoft Store in partnership with the Amazon Appstore, but the feature will be available in future updates.

Time & language

In the Time & language section, you will find that Windows once again brings together the "Language & region" settings into a single page with all the same settings as before. This section includes the Date & time, Language & region, Typing, and Speech pages.

On Time & language > Typing, the new page is new to this section. Previously, it was located in the "Devices" section, and like before, it includes the settings to configure the touch keyboard, suggestions, auto-correction, highlight misspelled words, typing insights, and more.

Privacy & Security

The Privacy & security section replaces the "Privacy" section available in the older version of the Settings app. It includes all the same pages as before like General, Speech, Inking & typing personalisation, Diagnostic & feedback, and Activity History, but it now also has the Searching Windows page.

In addition, there's a new Security section where you will find the settings for Windows Security, Find my device, Device encryption, and For developers.

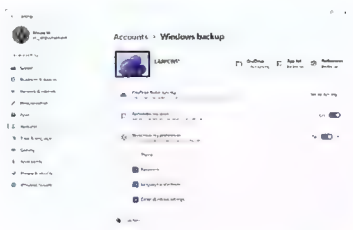
On Privacy & security > Device encryption, the page is new and includes the links to configure BitLocker on supported editions of Windows 11.

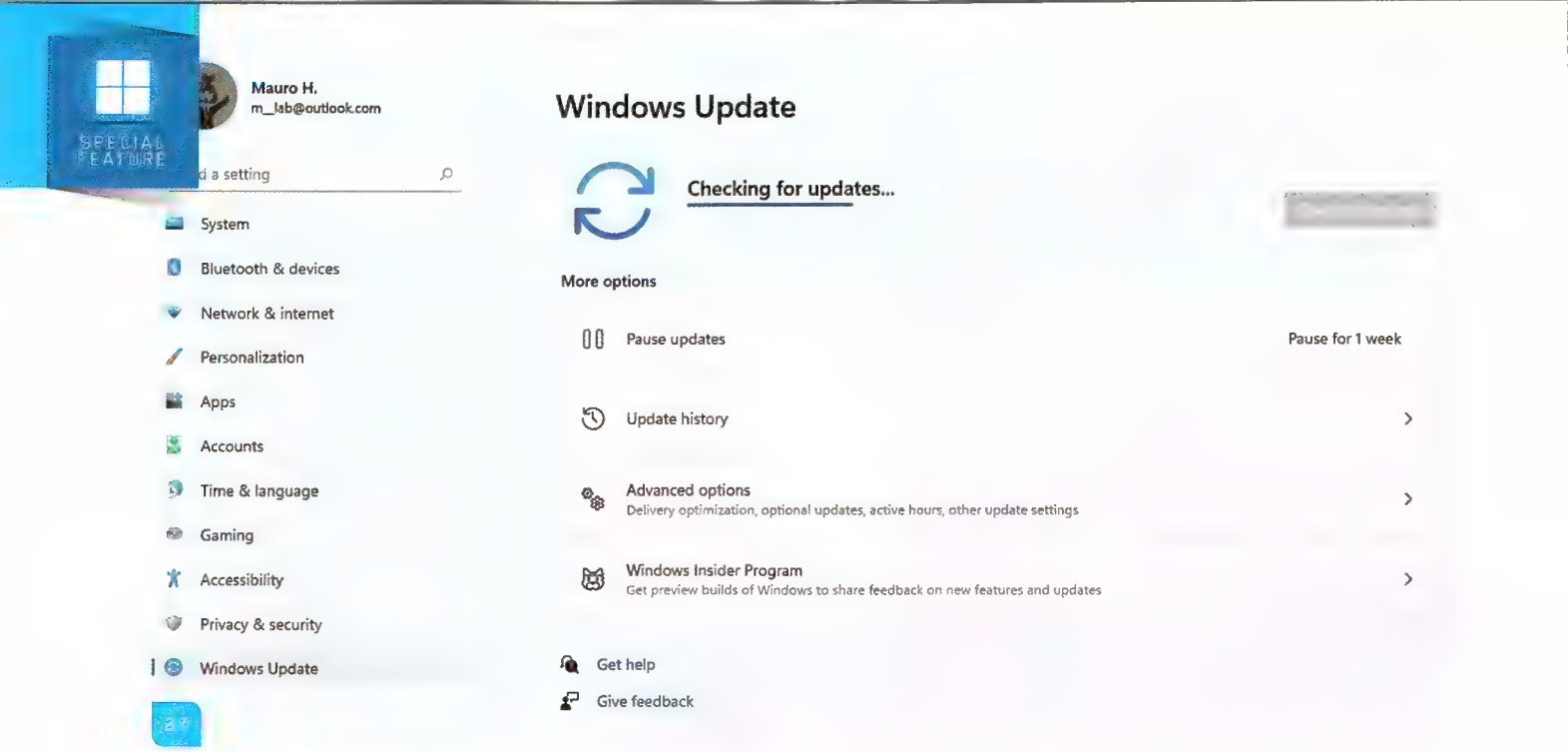
Accounts

In the Accounts section, the information about your account, rewards from Microsoft, and OneDrive backup information are the hero controls. This section houses the Your info, Email & accounts, Sign-in options, Family & other users, Windows backup, and Access work or school pages.

On Accounts > Windows backup, this page replaces the "Backup" page and no longer includes the options to access the legacy backup feature from Windows 7, nor will you find the settings to use File History to back up your files. However, you can still access these features from Control Panel.

The page now pushes users to use OneDrive to backup files and sync preferences to the cloud.





Windows Update

The last section is Windows Update, and while this setting isn't new, it now appears as its own category. The page features a visual element indicating the update status and a more prominent button to check for updates for hero controls. [27]

Also, there is a new animation for when searching for updates, and Windows 11 will now let you know the estimated time to install a system update. You will also notice that accessing the page will no longer trigger the update automatically. However, the system will continue to check and download updates automatically in the background.

Inside the "Advanced options" page, under the "Additional options" section, a new Configured update policies page will list any policy that your organization may have configured on the device.

Setup change

This flight introduces various other changes around the setup and startup process. Windows 11 Build 22000.51 also comes with a new out-of-box experience, which is the experience after the installation that guides you through the steps to complete the setup, including creating a new account, choose your privacy settings, and customise your preferences after an installation or on a new device.

The updated version of the OOBE features a modern and user-friendly interface with light colours, rounded corners, inviting animations, and new iconography.

Although most of the steps are the same as in the previous version of Windows, you will now be able to choose a name for your computer instead of generating one randomly. Windows 11 will show an option to restore your settings from previous setups.

If you install the Home edition of Windows 11, you will be required to connect to an internet connection and set up the device with a Microsoft account, which is not a step you can skip. However, you will still be able to create a local account after the setup. After completing the setup, during the "Getting things ready for you," you will see a new animation with new glowing colours.

Other improvements

In addition, Windows 11 now comes with support for Wi-Fi 6E. This is a newer version of the wireless technology 802.11 standard that has been designed to take advantage of the 6GHz band and other enhancements to increase higher transfer speeds.

Starting with Windows 11 Build 22000.51, Microsoft is no longer supporting the 32-bit version of the OS, which means that moving forward, only the 64-bit version will be supported. ■

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THE SCREENS OF TOMORROW

With chip shortages, the crypto-mining craze, and painful pricing for all kinds of components, we're hardly operating in normal times when it comes to PC tech. Without mentioning the p-word, let's just say the world has more to worry about right now than overpriced GPUs.

Excuse the pun, but screen tech hasn't been immune to the madness. Yet progress continues. In fact, after years of headline-grabbing advances in gaming panels, the next 12 months might offer the best chance to upgrade a tired productivity-oriented screen.

The introduction of the first mainstream OLED monitors this year is certainly a milestone. Likewise, wider adoption of mini-LED backlighting is a game changer. The mere availability of affordable monitor models that combine a quality 32-inch IPS or VA panel with 4K resolution and 120Hz-plus refresh could actually be what marks 2021 as a really significant real-world inflection point.

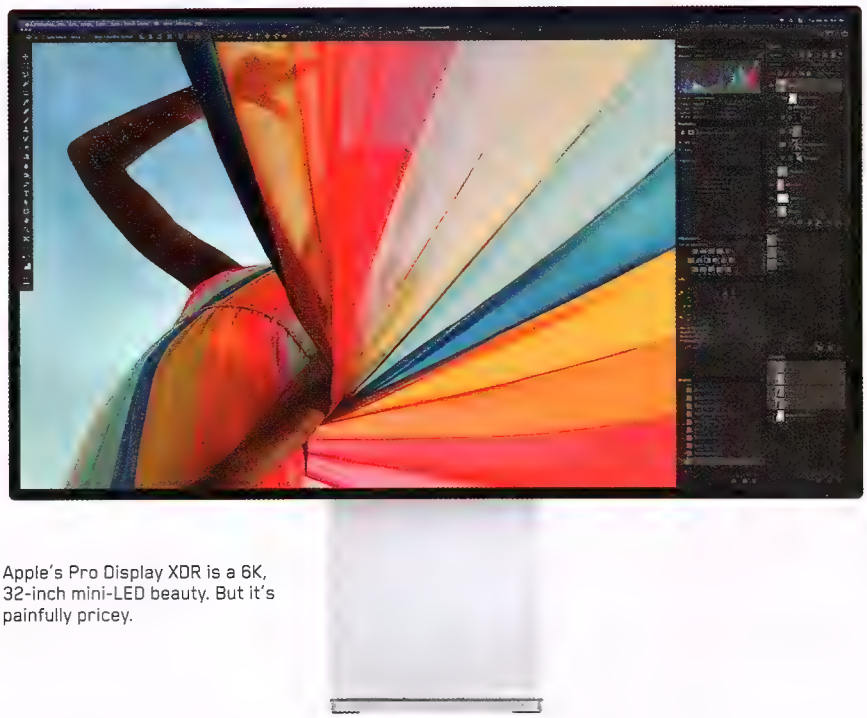
If the value of high refresh outside of a gaming context is debatable, the wider adoption of USB Type-C and the associated Thunderbolt 4 as the display interface of choice is surely an unambiguous win. So, if you've been holding out for an upgrade for that aging 1440p or 4K 60Hz SDR panel, it could be the time to finally pull the trigger.

Not that the next year or so will satisfy all your monitor-related hopes and dreams. The stubborn refusal of the market to embrace resolutions beyond 4K doesn't look likely to change anytime soon, for example. We'll all have to wait a few more years for that elusive high-DPI experience, at least when it comes to large-format displays where 4K doesn't deliver the goods in pixel density terms. But in most other regards, the incoming options look sweet.

Move over gamers, it's time for plain old productivity panels to get in on the upgrades, with Jeremy Laird.

For gamers upgrading PC monitors, the last few years have been going gangbusters. Refresh rates keep climbing. Features such as low input lag modes and adaptive sync are cheaper and more widely available than ever. Panels with all kinds of crazy curves and aspect ratios are now almost the norm. Forty-nine inches of uber-curved 5K gaming monitor running at 240Hz? Not a problem. You can even get a massive 4K OLED 120Hz gaming screen for a not completely insane amount of money, though that will strictly speaking be a TV and not a monitor.

The market for more productivity-oriented panels? Not so much. Four or five years ago, monitors offering resolutions around 4K in various shapes and sizes running at 60Hz refresh got cheap. Since then, bar one or two ultrawide options, there hasn't been a lot to upgrade to. At least, not for vaguely sensible money.



Apple's Pro Display XDR is a 6K, 32-inch mini-LED beauty. But it's painfully pricey.

Yes, HDR support has arguably made some inroads, but true 1,000-nit-plus HDR capability with per-pixel lighting in a PC monitor remains a long way off.

However, the next 12 months or so are beginning to shape up very nicely for anyone pondering an upgraded productivity panel for their PC. One really significant technological development is the introduction of mini-LED technology. You can check the boxout opposite for a deeper dive into the comparison between mini-LED and microLED. The short version is that mini-LED is a backlight technology for LCD panels, rather than an actual panel type. However, it still promises a big step forward in image quality and especially HDR performance.

That's because it allows for thousands of individually controlled local dimming zones. LCD monitors with conventional LED backlights and local dimming capability contain at most 300 to 400 zones. The ability to split the backlight into 400 individual zones may sound impressive, but on a 4K screen it means each zone is powering over 20,000 pixels.

Long story short, that relatively crude level of local dimming results in obvious image issues, including blooming around bright objects. White text on a black background is particularly problematic. Upgrade hundreds of zones to thousands of zones, and much more precise control of contrast across the panel becomes possible. As a consequence, this new wave of mini-LED panels will arguably enable the first LCD monitors with true HDR capability. The catch? As ever, it's cost. At least in the short term.

The very first mini-LED models are megabucks. Dell's 32-inch 4K UP3221Q has 2,000 zones and costs $6,000. The Asus ProArt Display PA32UCG-K packs 1,152 zones and commands a few hundred dollars more, while its 27-inch sibling, the PA27UCX-K, is yours for around $4,500, and makes do with just 576 zones. However, several mini-LED models are due later this year with more affordable pricing. Philips's 27-inch 279P2MRX, for instance, ups the ante to 2,304 zones and an eye-popping peak brightness of 1,400 nits. Philips hasn't quoted a price just yet, but we're hopeful the 279P2MRX will be one of a few more affordable mini-LED models.

Next up is OLED technology. It's been an awfully long time coming to the PC. But it's finally happening, and not just in laptops. OLED panels in premium laptops from big brands such as Alienware and Razer have been available for several

In recent years, the monitor market has been all about gaming panels like the crazy Samsung G9.

© samsung, apple corp, tcl

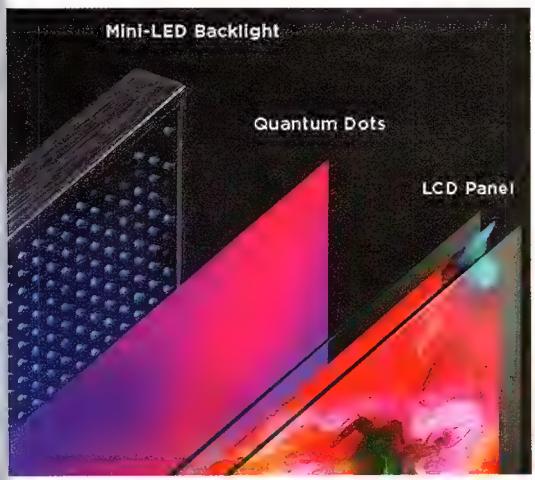
years with reasonable success. Attempts to introduce OLED technology to the desktop, however, have been much more problematic.

As long ago as January 2016, Dell announced the UP3017QA, a 30-inch 4K OLED monitor that seemed to signal a new era for desktop displays. It was delayed to April 2017 due to image quality issues, only to be discontinued two months later. With a peak brightness of only 300 nits and concerns over colour drift and burn-in, plus a $5,500 price tag, the UP3017QA never looked like a great prospect.

The Asus ProArt PQ22UC, another 4K OLED monitor, was announced in 2019. At a mere 22 inches, the PQ22UC is a niche offering. It can still be bought today, so it has at least lasted longer than the ill-fated Dell. For 2021, however, LG is introducing a pair of new monitors that represent the first real attempt at introducing OLED tech to the desktop.

The LG 32BP95E and LG 27BP95E are 32-inch and 27-inch 4K OLED monitors. Intriguingly, given LG is the world's biggest maker of OLED panels for TVs, both are based on panels made not by LG but bought in from a panel producer known as JOLED. It's a little detail that hints at the cost and complexity of tooling up application-specific OLED panels. Even the world's leading manufacturer of large OLED panels buys them in for some of its own screens.

Of course, neither of those two new LG monitors are terribly affordable. Which is why a new OLED panel from AU Optronics (AUO) in particular is good news. AUO doesn't make complete monitors, rather it sells LCD and OLED panels to display makers. The panel in question is a 32-inch item with 4K resolution and 144Hz refresh. That's a very sweet-sounding combination in



Mini-LED sounds confusingly similar to microLED, but it's essentially just the latest backlight technology.

MINI-LED VS. MICROLED

WHAT'S IN A NAME?

There are lies. There are damned lies. And there's flat panel marketing. It's common for LCD monitors and HDTVs to be sold as "LED" displays when, in fact, the LED bit is just a backlight. Let's not even start on the nonsense monitor makers get up to when it comes to specifications such as pixel response.

The way screens are sold is only getting more confusing with the emergence of two new LED technologies: mini-LED and microLED. They sound awfully similar, but they have vanishingly little in common. Mini-LED is just another backlight tech, albeit the most advanced yet, whereas microLED is a panel type in its own right.

In really simple terms, microLED is the future for display tech, the ultimate flat panel. Mini-LED is just the latest and greatest version of LCD technology. If that makes mini-LED sound like it's playing second fiddle, in technological terms it is.

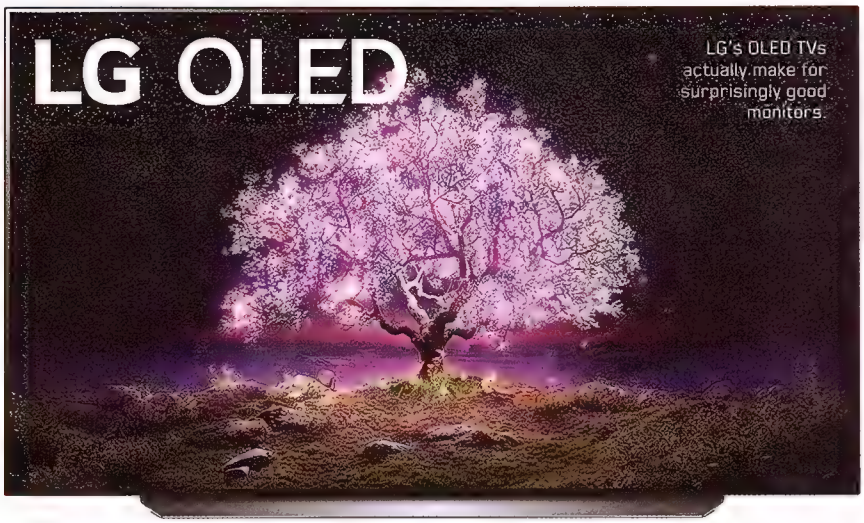
Even the best mini-LED panels come with nearly all the shortcomings of any LCD screen. Mini-LED does nothing to help with the limited viewing angles or relatively slow pixel response of an LCD panel. Indeed, it's remarkable just how good LCD panels have become given how unsuitable the technology is for full colour motion images. But however good the backlight technology, LCD will remain a flawed transmissive technology.

What mini-LED does achieve is improved contrast control and supercharged HDR performance. Essentially, mini-LED involves an array of thousands of tiny LED lights, typically grouped into individually controllable zones. A panel might have tens of thousands of LEDs, but fewer zones, perhaps a few thousand. The idea is to achieve more finely grained control over backlighting and reduce problems such as blooming around bright objects or white text on a black background, which are common issues on existing LCD monitors.

In comparison, microLED has numerous advantages. It's pretty much the same as OLED technology, but without the burn-in issues and with much higher brightness. If that sounds like the perfect display, well, it probably is. It's the ultimate in per-pixel lighting, for sure. No brightness limitations, fantastic viewing angles, near infinite contrast, near instant response…. What's not to like?

There's a catch. Until recently, microLED was limited to tech demos and a few expensive displays aimed at commercial installations. That is now beginning to change. At CES this year, Samsung showed off its "consumer" microLED TVs. They are more conventional screens than any previous microLED display, with full feature sets including smart TV and audio capabilities, plus HDMI inputs, and everything you need to plug in and watch stuff. But the 110-inch variant is over $100,000.

Granted, cheaper variants are due any day, shrunk down to a paltry 88 inches. But you're still looking at $50,000's worth of TV. Which means we are at least five years away from affordable microLED TVs. Sadly, microLED PC monitors will be even further out.



LG's OLED TVs actually make for surprisingly good monitors.

IS OLED REALLY ALL THAT?

THE TECH WE'VE BEEN WAITING FOR...

The prospect of OLED panels on the desktop has tantalised PC enthusiasts for the better part of a decade. It now looks like OLED is going to make the transition from HDTV to desktop monitor, but is OLED really all that?

For sure, it brings huge advances over LCD tech. OLED's defining advantage is per-pixel lighting – each pixel is its own light source, creating the possibility for total precision when it comes to contrast and dynamic range. With OLED, you can have a single pixel running at full brightness next to one completely switched off and outputting no light at all.

Even the latest LCD panels with mini-LED backlights don't come close in that regard. Even with thousands of dimming zones, the net result is still tens of thousands of pixels sharing a single zone. And that means the dreaded blooming around small and bright objects, including white text on dark backgrounds, is inevitable.

Of course, OLED has several other upsides, too. As a self-emissive tech, it has better viewing angles than transmissive LCD panels. OLED is much faster, too. Independent testing has proven that full on-off OLED pixel response is measured in fractions of a millisecond. Even the fastest LCD panels take several milliseconds to achieve on-off response, as opposed to partial gray-to-gray response.

However, OLED isn't superior by every metric. LED-backlit LCD panels, for instance, can achieve much higher peak brightness. The brightest LED TVs can hit nearly 2,000 nits, while even the latest generation of OLED tech can't even achieve 1,000 nits. And that's peak brightness in isolated hotspots. If it's full-panel brightness you want, OLED tops out below 200 nits.

In the real world, every pixel running full white isn't terribly relevant. But the brighter the overall scene being displayed, the more OLED panel brightness drops off. And that's a real problem when it comes to HDR rendering.

It all comes down to the way HDR content is processed for output to take into account the abilities and limitations of human vision. Known as Perceptual Quantization, or PQ for short, this transfer function includes a model of the granularity of human sight or the ability of the human eye to perceive two different levels of light.

To cut a long and technical story short, an overly bright display can cause the degradation of what should be smooth colour transitions or gradients into blocks or bands of abrupt colour changes. If the display is too dim, details in bright areas bloom or bleed into one another, resulting in the loss of finer elements as large areas flatten out and become featureless. Anyway, in brighter HDR scenes, OLED technology lacks detail compared to the best LCD panels.

OLED's other obvious weakness involves burn-in. That's a problem thanks to differential degradation within the RGB subpixels. The blue subpixels wear out faster than the red and green subpixels, leading to colour drift that manifests as permanent image burn-in. Yuck. It's not a huge problem for video, with constantly changing images, but Windows, with its persistent taskbar, menus, and the rest, is prone to generating screen burn-in on OLED displays.

theory. In practice, monitors based on the panel have yet to be announced. So, details such as pricing aren't clear. However, AUO has a track record of undercutting its competitors in terms of cost. Here's hoping for a 32-inch 4K 144Hz OLED monitor for under $1,000 by the end of 2021.

Ironically, the most affordable OLED monitor yet will probably turn out to be a TV. Already, several LG OLED TVs have been adopted by the PC gaming community as large-scale gaming screens. The LG CX and C1 have proven very popular thanks to reasonable pricing and a combination of 4K resolution, 120Hz refresh, and OLED's characteristically super-fast response. The catch is that the smallest panel size available thus far has been 48 inches. Not only is that ergonomically problematic for a desktop monitor, it also makes for a disappointing pixel pitch of just under 100 dpi.

Happily, that's set to change very soon. LG has announced plans to introduce a new 42-inch class of OLED panel later this year that will both be more suitable in terms of size and should also be cheaper than existing 48-inch OLEDs. A 42-inch, 120Hz, 4K OLED display for around $2,000? Sounds good to us. Granted, it won't strictly be a PC monitor, but with features such as low input lag mode with minimal image processing, LG's latest OLED TVs have proved remarkably well optimised for use as a desktop monitor.

Back in the mainstream, a new sweet spot is emerging in mid-market monitors that combines a decent IPS or VA 4K 32-inch panel with 120Hz or 144Hz refresh. Admittedly, high refresh rates have largely been the purview of gaming monitors. There's certainly little to no benefit outside of gaming in going well beyond 144Hz. A 360Hz productivity panel? That would be very silly. But in terms of making desktop computing feel slicker and more responsive, 120Hz to 144Hz is a nice little upgrade.

Is it worth spending megabucks on a general-purpose display? No. Which is why, somewhat incongruously, the latest 4K 120Hz games consoles from Microsoft and Sony are coming in handy. Put simply, the gaming console market is particularly sensitive, placing a downward pressure on relevant peripherals, including screens. And so a new generation of monitors aimed at those consoles is good news for all PC enthusiasts.

By the end of 2021, several console-friendly 32-inch 4K monitors with circa 120Hz refresh capability will be available for perhaps as little as $1,000. They'll be 32-inch because that slightly

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larger format is more suitable for gaming than 27-inch. Which again represents a welcome fringe benefit in a productivity context, thanks to the additional space it provides for viewing multiple documents and application windows in parallel. What's more, because gaming monitors increasingly need to deliver at least basic HDR performance (note these aren't fancy mini-LED monitors, which is part of the reason why they should be competitively priced), color accuracy should be good enough for most workflows, albeit you'll still need a proper pro display for really serious content creation.

Examples of this new affordable 32-inch, 4K, 120Hz-plus brigade include the Philips 328M1R and 329M1RV with VA and IPS panels respectively, the ViewSonic ELITE XG320U with HDR600 and an IPS panel, and the HDR400 and IPS-equipped AOC Agon AG324UX. The way things are currently going with crazy prices attached to everything from puppies to Porsches, of course, we may all have to wait just a little bit for prices of this class of panel to hit that $500 marker. But that's roughly what we're expecting in the medium term.

If those are the most intriguing trends regarding the screen tech coming to the desktop monitor market, what about the stuff that probably won't show up any time soon? The most notable absentee is the wider availability of really high-resolution panels. The 32-inch 6K panel seen in Apple's Pro Display XDR is thought to be produced by—yes, you guessed it—LG, and would make a great basis for a high-end but still much more affordable PC monitor shorn of details such as the megabucks Apple chassis and mini-LED backlight. But thus far it has yet to appear in any other monitor. Rumor has it Apple has secured exclusive access for now.

Thinking about an 8K TV as a PC monitor? You'll need one of AMD or Nvidia's latest GPUs.

Of course, the next big step in terms of resolution ought to be 8K. Like OLED panels in desktop monitors, 8K monitors have been available for several years, including the Dell UP3218K. As yet, however, there's little to no indication 8K is set to go mainstream at anything like the pace that 4K did in the mid-2010s. As an example, ViewSonic has a new 8K panel that's due any day now, the VP3268-8K. But it's expected to land at $5,000. Yup, that's even more expensive than the $3,999 Dell asks for the UP3218K. Moreover, none of the big players in actual LCD panel production, as opposed to complete monitor manufacture, have announced anything that looks like a cheaper 8K option.

If there is hope for affordable 8K desktop monitors, it comes from that same source as the first really affordable 4K screens, namely the HDTV market. 8K is beginning to enter the mainstream in terms of HDTV pricing, with sets from big brands such as Samsung and LG occasionally dipping below $1,000. Now, HDTVs are not PC monitors. In fact, in the early days of big flat-panel TVs, they made for very poor PC monitors.

There's a long list of reasons for that, including ergonomics, picture quality, pixel pitch, lag, and more. But with the advent of 4K, plus features such as low input lag modes with minimal image

The Philips 328M1R is one of a new class of relatively affordable 32-inch 4K high refresh panels.

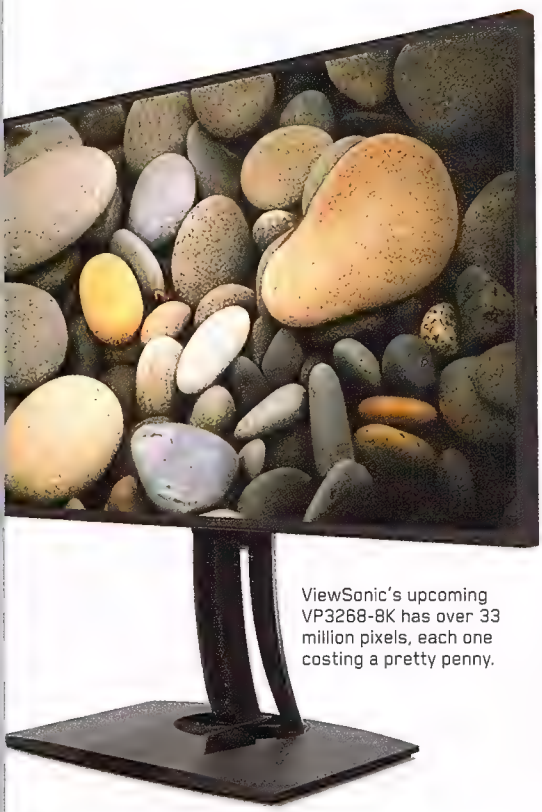
Dell's mini-LED monitor packs two thousand dimming zones.

© Dell, Nvidia, Philips, Viewsonic

processing, HDTVs have become viable as PC monitors. As we mentioned, if you want an OLED panel on the desktop, it's the only vaguely affordable option today.

Shift the context to 8K and the immediate problem is bandwidth. 8K is four times the pixel count of 4K, some 33.2 million pixels, and 16 times the resolution of 1080p. That requires epic bandwidth. Both DisplayPort 1.4 and HDMI 2.1 are capable of driving a display at 8K 60Hz. DisplayPort isn't a common feature on TVs, so HDMI 2.1 is the interface of choice in this context. Unfortunately, that means forking out for an Nvidia RTX 30 series or AMD Radeon RX 6000 graphics card, the only GPUs with HDMI 2.1 support. If you can find one to buy, that is.

If you can, does an 8K TV as PC monitor actually make any sense? Well, it's not something we've tested. However, it's worth noting that a 55-inch 8K TV, currently the smallest available, has about the same pixel density of 160 dpi as a 27-inch 4K monitor, and significantly better pixel density than a 32-inch 4K panel. Yes, 55 inches will be far too big for many desks, but the basics of the image quality are promising. Should 8K make the step down to the 40-something-inch class of HDTV, that will be seriously interesting. If that does happen, here's hoping GPU prices and availability are back to something even resembling normality in time.



ViewSonic's upcoming VP3268-8K has over 33 million pixels, each one costing a pretty penny.

The USB Type-C interface is seriously slick and simple to use.

GET CONNECTED

USB-C IS ABOUT TO GET EVEN BETTER

Display interfaces are not obviously aspirational or exciting. Certainly, they're critical enablers of good display technology, but we're into the realms of the mundane and functional when it comes to comparing HDMI to DisplayPort, right?

Perhaps. But if there is an exception, a display interface that's so slick and clever it's actually cool, it must be USB Type-C and its Thunderbolt cousin. If you're a laptop user, the ability to plug in a single cable to drive an external display, charge the laptop itself, and also connect peripherals including input devices and external storage is liberating. Slap that notebook down, shove in just one cable, and you're almost instantly good to go. USB-C is far tidier, too. Once you've experienced a USB-C monitor, you won't want to go back to that rats' nest of cables.

If that's all the good stuff, USB-C does have some limitations. The actual bandwidth available varies, which in turn restricts options in terms of things like screen resolution and refresh, plus the bandwidth available to devices such as external hard drives. The other shortcoming is a maximum power delivery of 100 watts, which isn't enough to feed a really powerful laptop PC running under heavy load.

Bandwidth and connectivity-wise, the next step up involves monitors supporting Thunderbolt 4 and USB 4. They'll be backward compatible with existing Thunderbolt 3 and USB-C devices. Ultimately, Thunderbolt 4 and USB 4 are almost the same, the main distinction being that Thunderbolt 4 always delivers fully 40Gb/s of bandwidth while USB 4 has an optional 20Gb/s implementation. Thunderbolt 4 cables supporting that 40Gb/s can be up to two meters long, while Thunderbolt 3 was limited to 0.8 meters at maximum speed.

For context, 4K at 60Hz refresh requires 12.54Gb/s of interface bandwidth while 4K at 120Hz increases that to 25.82Gb/s. So, a Thunderbolt 4 or full-speed USB 4 connection could drive a display at 4K120 and still have nearly 15Gb/s or a little under 2GB/s to spare for peripherals and storage. The real-world usable bandwidth will be a bit less. But even 1GB/s for an external SSD would be decent given the simplicity and convenience of that single-cable solution.

As for power, the USB Implementers Forum recently announced a new Extended Power Range (EPR) definition known as USB-PD R3.1. It increases the maximum power of USB-C charging from 100W to 240W. Plenty for all but a few outlier portable PCs. But that level of power also comes with some specialised requirements.

Sockets and cables supporting EPR will need tweaks to prevent shorting and arcing, especially when unplugging. Part of the solution is to make the CC and VBUS pins different lengths, thereby allowing the detection of disconnect events early enough to enable the power source to reduce current prior to full disconnection. A snubber capacitor at both cable ends is also recommended to help ensure this new upgraded USB-C interface doesn't set sparks flying.

A parent's guide to programming

Mike Bedford investigates which languages to consider if you want to help your children get a head start in coding.

Let's start with a history lesson. The first high-level languages – which made their debut in the 1950s and included the likes of FORTRAN, ALGOL, and COBOL – were designed as down-to-earth tools with little thought given to education. This changed in 1964 with the introduction of BASIC. The language's acronym hints at its nature, and its full name, Beginners All-Purpose Symbolic Instruction Code, emphasises its educational credentials. Indeed, BASIC was designed for use by students who had little appreciation of computers. It outlived other languages of that era, having been adopted for use in the home computers of the late '70s and '80s, and helped another generation learn to code.

While BASIC remained largely unchallenged for several decades, if you want to help your children learn to code today, it's not nearly as easy to choose a language. For a start, there are now several other languages that were designed exclusively, or almost so, for education. Also, any discussion of beginners' languages invariably brings up various languages which, although not originally intended for such, are considered to have a role in education.

We're here to help you navigate your way through the language jungle to decide which would be the best for your children to learn. We consulted Carrie Anne Philbin, director of educator support at the Raspberry Pi Foundation, who also helps develop curriculums for education institutions, and she provided some useful insight into the various languages we consider here. Her opening remark is worthy of our attention. "I guess the most important information I can impart is that in education – both formal and non-formal – we do not start with a programming language," she explained. "We always start with concepts, usually offline, before using

tools that help learners make the concept more concrete in their minds."

Scratch

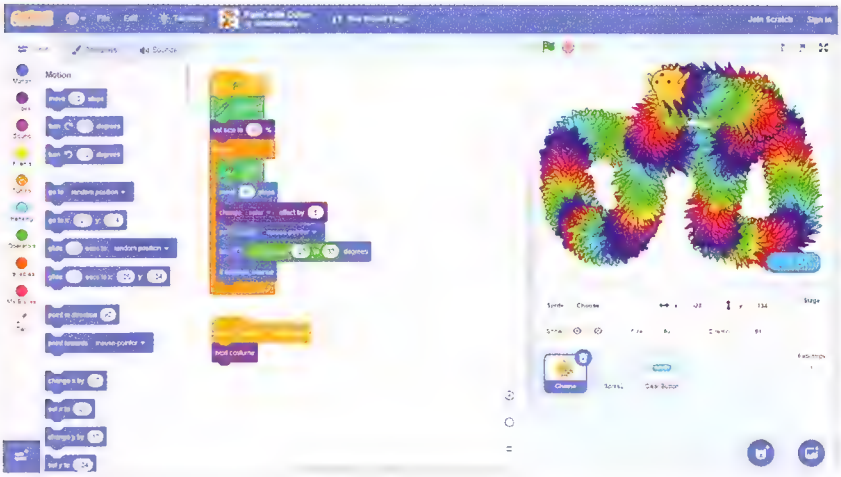
If you've not delved into educational languages before, it's possible you've not encountered block-based languages. In passing, that term is entirely different from block-structured, the concept that's key to structured programming and inherent in most of today's programming languages. By way of contrast, a block-based language involves programming by dragging blocks – which we can think of as statements – from a palette on to the scripting area, and editing by manipulating those blocks in the scripting area. In other words, it needs little in the way of free-form typing, the requirement being pretty much limited to editing things such as the time in a wait block or the distance in a move block. Ease of use is also enhanced by virtue of the blocks being shaped somewhat like jigsaw pieces, an approach that slightly reduces the possibility of using a block in a nonsensical context.

Scratch is our first block-based language – it's free, multi-platform, and open source, and it was developed by MIT's Media Lab. Scratch is the block-based language primarily recommended by Carrie Anne Philbin, who suggests that it's suitable until a transition to text-based languages, typically at age 11 to 13, although for ages five to seven, the closely related Scratch Jr. should be the language of choice. Scratch is used in formal education, as well as in non-formal education in homes, and in after-school clubs, such as Code Club and CoderDojo.

You can install Scratch locally or run it online at **https://scratch.mit.edu**. However, Scratch Jr. is only available as an app, intended for use on tablets, and is available for iPads and Android devices.

Blockly

Developed and hosted by Google, Blockly is our second block-based language and, although it's sometimes thought of as such, it appears that its developers didn't design it exclusively for educational use. This being the case, it's probably not too surprising that it's less basic than Scratch and, therefore, suitable for creating real applications. Indeed, while we trust that the statement doesn't consider educational resources as toys, Google specifically says "it's not a toy" and you can use it to "implement complex programming tasks." Despite being developed by Google, Blockly is an open-source project.



According to Carrie Anne, Scratch dominates the block-based sector, so Blockly is used when it has to be, for example when programming in App Inventor (**https://appinventor.mit.edu**), or with the micro:bit single-board computer, where Scratch wasn't supported at first. We were also told that Blockly is closer in design to a text-based language. For that reason, it's suitable for older children between the ages of 10 and 14, and it's not recommended for young ages.

Blockly runs in a browser from **https://developers.google.com/blockly** and it offers the interesting feature of generating and displaying the code in a range of text-based languages – specifically JavaScript, Python, PHP, Lua, and Dart – that correspond to the block-based code. We can imagine that this could have some value in the process of migrating from a block-based to a text-based language. While Python and JavaScript

Its block-based approach might be unfamiliar to experienced programmers, but Scratch is highly recommended as a first language.

Bee-Bot and Blue-Bot

For especially young children, even those for whom using a block-based language might be a step too far, Bee-Bot ($135) or Blue-Bot ($230) might be of interest. Referred to as programmable floor robots, and typically used with mats that the robots can be programmed to navigate, these devices don't have to be programmed via a language at all. Instead, they can be programmed by pressing buttons on the robot's body. So, for example, if you press the "Clear" button, followed by "Forward" twice, "Right turn," "Forward," and "Go," the robot moves forward by 300mm (2x 150mm), turns right 90 degrees, and finally moves forward by 150mm, with a short pause between each step. While this isn't programming as we normally use the word, it is, of course, exactly that, and it teaches some key principles.

Turning to Blue-Bot, you can use this in the same way as Bee-Bot, but there's more. First, it's transparent, so inquiring minds can get a feel for the hardware that controls it, but more importantly, it has a Bluetooth interface. This enables kids to progress to controlling the robot remotely from a handheld device, albeit only Windows, iPad, or Android. To cut a long story short – and it does more – the free app makes it possible for kids to create a program on screen via a simple process, download it to Blue-Bot, and execute it.

Bee-Bot offers young kids a fun way to program a robot by pressing the various buttons on its body.

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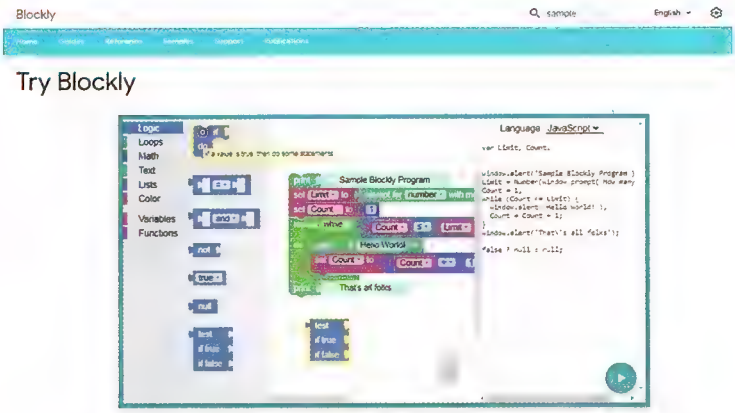


Google's Blockly is block-based, but it can be used for creating real applications. As an educational language, it's more suited for older kids than Scratch.

are obvious choices in this respect, Lua and Dart might be somewhat surprising. Although Scratch and Blockly aren't the only block-based languages, they're the ones we hear most of by far in education.

Now we'll turn our attention to the text-based languages that most of us are more familiar with.

BASIC-256

Given that it's 56 years old, has missed out on many of the more recent programming paradigms, and it draws some criticism, we were unsure whether we should include BASIC. However, since it's still used professionally, albeit in its guise of Visual Basic, and it still gets recommendations as a language for kids, it's appropriate to consider it here. As perhaps the most commonly cited modern(-ish) implementation for educational use, it's BASIC-256 that we're looking at. Unlike the original BASIC command-line implementations, this version takes the form of an integrated development environment (IDE), with windows for the code, textual output, and graphical output.

This version of BASIC was developed in 2007 specifically for teaching programming. Like BASIC of old, but unlike some of the more recent versions, flow control is pretty much limited to GOTO, GOSUB, FOR...NEXT, and IF...THEN...ELSE... ENDIF. While this contributes to its simplicity, this is the source of some criticism. It's argued that it doesn't teach the principles of structured programming, instead promoting "spaghetti code." To counter this, many people have said that they learned to program in BASIC and it didn't prevent them having a successful career in software engineering, using a range of languages.

In light of this, we elicited the view of Carrie Anne who, while not giving a specific answer to our question of whether it has any place in education today, said that BASIC isn't a common choice anymore, while also stressing her earlier comment about the basic principles coming before tools: "Learners are taught concepts first, not languages. Concepts can be applied to any language, so the next choice is based on what is freely available and comes with access to resources and support."

Logo

Another educational language that isn't exactly a newcomer is Logo. There are several versions that run locally, UCBLogo being well respected, and it can also be accessed online, for example at **www.transum.org/software/Logo and www.calormen.com/jslogo**. Logo is a full-featured programming language, and is described as "multi-paradigm," although its use in education has tended to concentrate on just one element of the language. This is the "turtle" functionality that controls the movement of a so-called turtle, drawing its path on the screen, and thereby producing a graphical output.

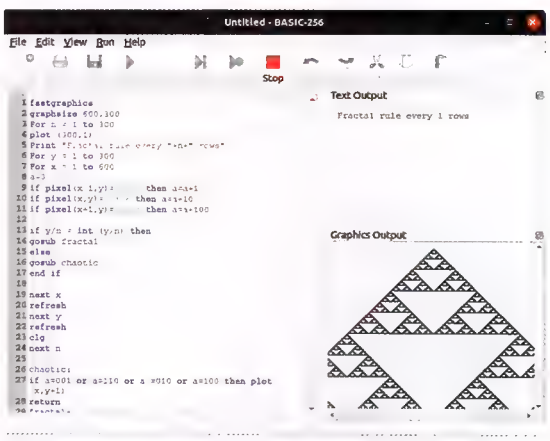
Given that there are only a few turtle statements, Logo offers a simple introduction to text-based programming and could be a first step beyond the block-based approach, perhaps for kids much younger than 11, which is the recommended age for starting with text-based languages. What's more, programming to create a graphic output appeals to young minds.

However, we had nagging doubts about why it receives less attention than it did a few decades ago. Might this be because more modern languages are much better suited to its particular niche? Carrie Anne was certainly enthusiastic about the use of turtles. "The use of turtles is very common in programming education," she suggested, "from using Bee-Bots in elementary schools to understand sequence and algorithms, to building Raspberry Pi robot buggies in high school to solve more complex mazes."

Sonic Pi

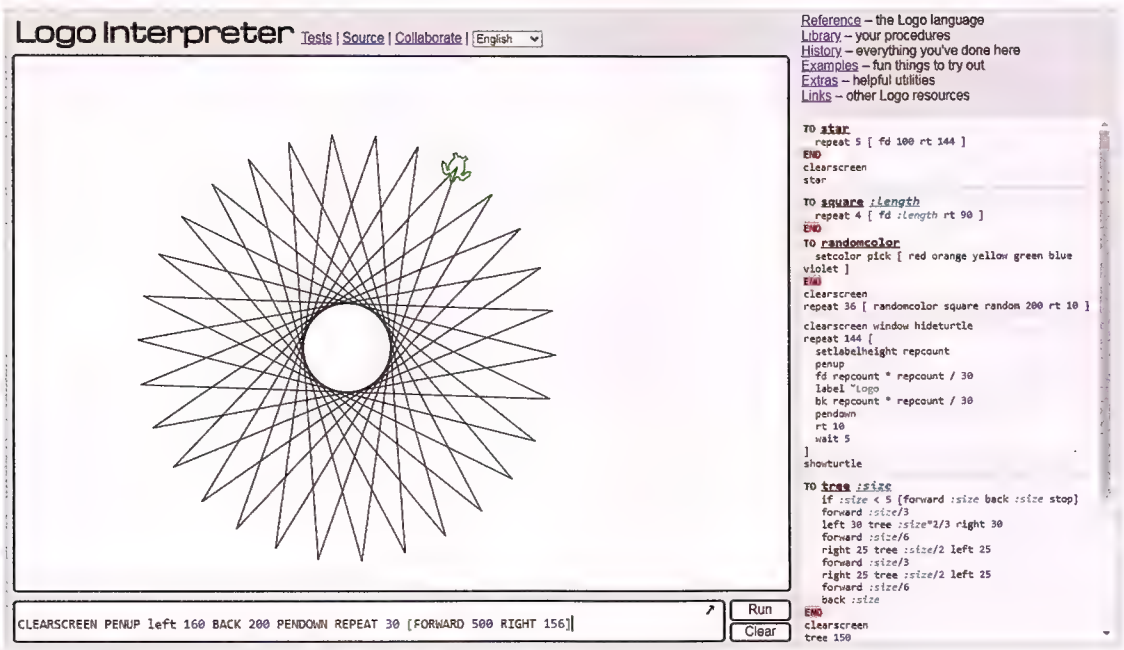
Sonic Pi (**https://sonic-pi.net**) is described as a code-based music creation and performance tool. The tool runs under Raspberry Pi OS (it was developed in conjunction with the Raspberry Pi Foundation), as well as Windows and macOS. It's also referred to as a live coding environment. This means that performers write code on the fly to create music as they're performing. We might think of it as enabling a digital jam session. Where things differ, though, is that it's common to project the live code on to a screen during performances, so the audience can share in the coding experience.

It's used by professional artists, but it also has educational value, especially for kids. According to its developer, Sam Aaron, writing for MagPi magazine, "Sonic Pi was conceived and built within classrooms in close collaboration with teachers and has benefited from many design iterations based on hundreds of hours of student observation. Simplicity has even been baked into the core design philosophy by only allowing features that may be easily understood by and taught to a 10-year-old." And while this hints at its simplicity, it's based on the Ruby programming language, so the sky's the limit.



BASIC certainly has its critics but, despite the controversy, the BASIC-256 dialect is being promoted for educational use.

© google, BASIC-256



Despite being long in the tooth, Logo still has its fans and, if you consider only its "turtle" instructions, it might be ideal as a first text-based language for kids.

Python

With our next language, we progress from those that were designed first and foremost for education to general-purpose languages. As today's third most commonly used language, that reason alone might be enough to guarantee it a place in education, but there's more. In particular, Python is commonly recommended for educational use – and, in particular, as a first text-based language – primarily because it's much simpler to learn than many other languages.

Carrie Anne suggested that ease of use isn't the only factor in its prevalence in education. Other reasons for the popularity of Python include the fact that it's free, cross-platform, and open source. She also pointed out the many IDEs that have been developed over the years, which meet the needs of education, such as Mu (**https://codewith.mu** – described as a simple Python editor for beginner programmers) and trinket (**https://trinket.io**, which is browser-based). Resources for teachers are also important, leading to its use in schools and therefore underlining Python's suitability for home learning. "At the NCCE, much of our professional development is based on Python," she said, "which means, in turn, they're likely to use it as their text-based language in the classroom." Building on this theme, she also referred to the fact that other resources to help teachers are overwhelmingly built around this language and are often freely accessible, such as the Raspberry Pi projects (**https://projects.raspberrypi.org/en**). Python is considered suitable for ages 11 and older.

C++

In industry, C++ is still commonly used. In fact, it's just one position behind Python in the well-respected TIOBE index (a body that assesses the quality of software coding), in fourth position. This is one of the reasons it's recommended as a suitable language for use in education. After all, if it's so commonly used, it's argued, a knowledge of C++ will provide students with good job prospects or a good grounding for further education.

Another plus point, according to some educationalists, is that it provides students with a good understanding of how computers work, because it's a much lower-level language than most of the other languages promoted for use in education, in the sense of being just one step up from assembly code.

Other languages

While we've probably covered the programming languages that are most commonly used in education, they aren't the only ones. A brief mention of a few alternatives is appropriate – indeed, Carrie Anne mentioned a couple.

Her first suggestion is probably somewhat surprising, since the language is only in fourteenth place in the TIOBE index. However, it has to be admitted that it's necessarily a show-stopper in education since, for example, Scratch is down at position 21. "Ruby is becoming more popular in education. Sonic Pi is a good example of an accessible tool that helps you code music, which is also used to help teach programming concepts to young people, based on Ruby. It's accessible as a language, while its simple syntax makes it more accessible to young people," she said.

To conclude, we feel compelled to reiterate Carrie Anne's view that understanding concepts is actually more important than learning specific languages. This being the case, in addition to considering the pros and cons of the various languages that we've presented, and making sure you don't introduce your kids to languages that aren't appropriate for their age, it's also valid to think about what languages you feel confident to teach. Even so, if you've recently been employed maintaining legacy systems, so you're up to speed with vintage languages, we're really not too sure that teaching COBOL to your five-year old would be the wisest approach. ■

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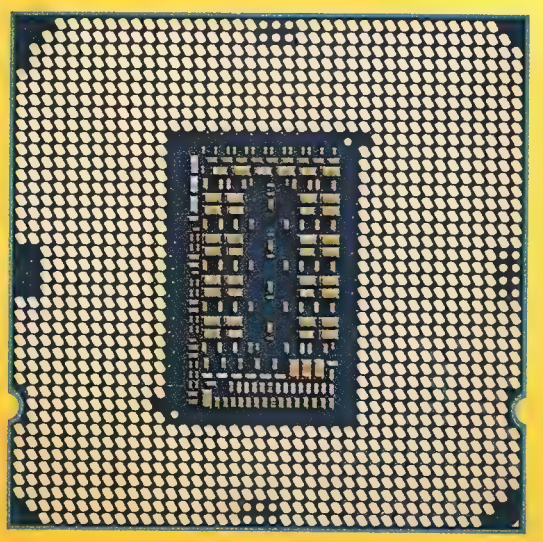
THE ULTIMATE BUILDER'S GUIDE

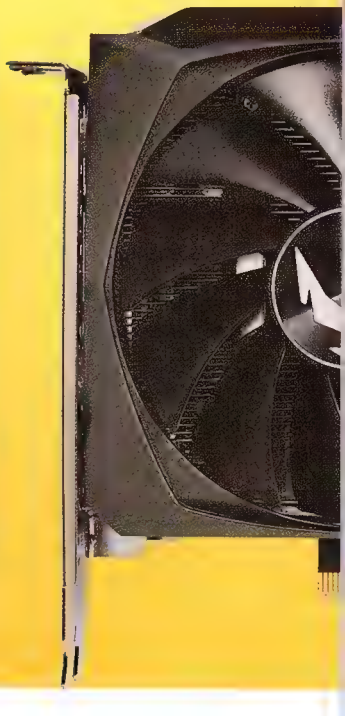
Take a peek at how we go about building PCs, as there's always time to learn something new.

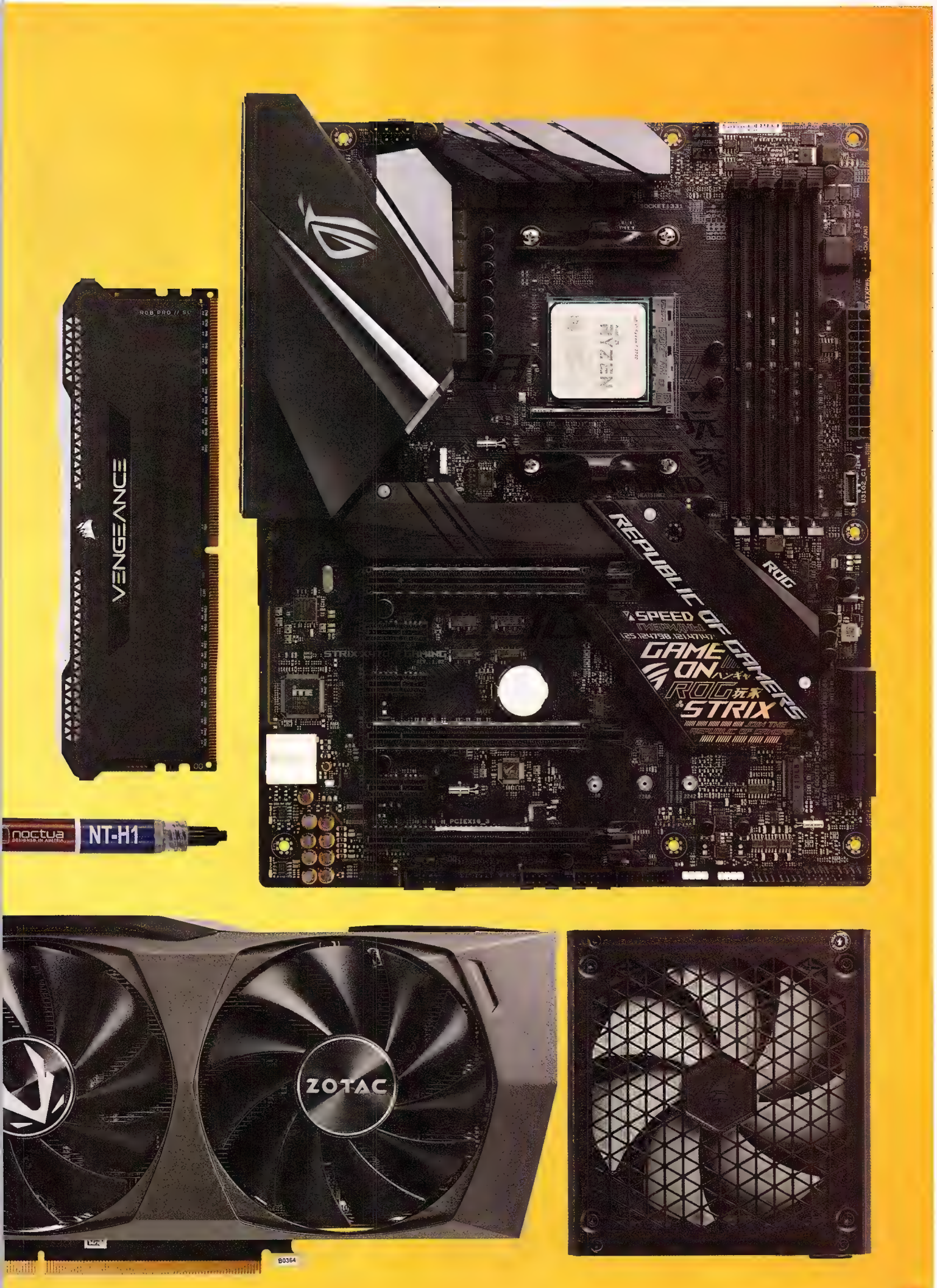
By Christian Guyton and Sam Lewis.

Whether you're a PC-building veteran who has more machines under their belt than PC Case Gear, an intermediate builder who's comfortable but has scope for more knowledge, or if you have all the gear but no idea, this guide contains all the tips and tricks to make building a PC an enjoyable experience. If you are reading this, chances are you have a keen interest in PCs, and even if this article isn't immediately helpful, it will be at some point in the future.

Custom PCs are our true love; they aren't necessarily cheaper, and certainly aren't easier than a pre-built plug-and-play machine, but the advantages are significant. The sky is your limit (well, that and your wallet), but you get full control over what goes inside and how you want your PC to perform. Remember: There may be problems along the way, even if you are an old hand, so here are 38 tips to help make your builds go smoothly.






VENGEANCE
noctua
NT-H1
REPUBLIC OF GAMERS
ROG
SPEED
GAME ON
ROG
STRIX
ZOTAC

(01) Plan ahead

Before you start getting your sledgehammer out, you need to think about what you want to use your PC for predominantly. Also, for legal reasons, please don't use a sledgehammer or any large destructive tool for your build – many thanks. Back to what you want; you could be after a PC that is completely productivity-focused for video editing or designing, or maybe you want gaming monster that can run at ludicrous FPS and shatter all other PCs within a 50-mile radius. Even if you just want one for work and the odd bit of Netflix, it's important to nail down what demands you want to make of your PC, as this determines what parts you need. The difference could even affect which OS you use (that's right, we're not just shills for Windows 10). So, make sure you research what makes your ideal PC perform to its best. Also consider where you will put your PC and how you want it to look; will it be on display? Tucked under a desk? Sitting in your living room? Remember: Planning your build always comes first.

(02) Research

The internet is filled with useful information on PC components, hardware specs, reviews, and tutorials to help in your build. Video guides, in particular, give a great insight into how a part functions, looks, and fits inside a build. When finding out what components to get, research similar builds and you'll eventually get an eye for what makes that system good for its intended purpose. You will likely find a common denominator and from there you can look at how to complement that component with other parts. It is also worth looking on the manufacturer' websites and through their PDFs for installation advice, and a component compatibility check on pcpartpicker.com wouldn't go amiss, either. It's a great place to start virtually piecing together your PC parts. All of this is essential before diving deep into your new rig.

(03) Bare essentials

When building a new PC, the place to start is the case; we always recommend this. Take a good look around, making sure everything is as it should be, and strip it all down. Remove any side panels, dust shields, and windows. To help with airflow and cable management, it's best to remove any hard drive cages and additional mounting brackets if you're not using them. This maximises negative space, producing more room for you to keep things neat and tidy. Unfortunately, we all know that tempered glass panels are a fingerprint magnet, so be careful that you don't smudge all over it when removing this panel. New cases usually come with a protective film over any glass parts, so wait until you're done building to take this off.

(04) Pick a fan

For both rockstars and PCs, fans are essential (sorry). The bottom line is that a PC would inevitably overheat and cook if it weren't for the intake and exhaust fans that regulate the internal temperature. There are two categories that fans fall into: bulky static pressure models and thin, many-bladed airflow fans. The former is designed for high-pressure environments, such as moving air through a thick heatsink. The latter moves air faster through the case, but with reduced force. Mounting multiple airflow fans provides good airflow to your PC, shockingly enough. Static-pressure fans, however, are vital for radiators if you choose to run with an all-in-one cooler. Some fans utilise magnetic bearings to "levitate" the fan inside its casing, which prolongs the lifespan and reduces noise, but naturally comes with a larger price tag. Most modern PC case fans use ball-bearing mounts, which should still last for around 60,000 hours at 50 C.

You should start any build with a bare, stripped-down case.

(05) Fan management

Luckily, most cases come with one or more fans pre-installed. These are typically stock manufacturer fans, or sometimes fans from a partnered brand. They do the job when it comes to keeping your PC cool, but generally won't stand up to fans from dedicated manufacturers. If you're after a silent build or cooling overkill for many sessions of demanding rendering tasks, there are plenty of better options out there than the stock fans. If you plan on upgrading the stock fans, make sure you do this before installing anything else (or simply remove your motherboard assembly as one unit first if you're upgrading an existing system). Things can start to get tight and awkward inside the case, so it's best to get any clutter out of the way. Consider keeping the stock fans as well as new fans if you've got the room; the more the merrier. If

These are the same fans with different blades. The thicker blades are optimised for high pressure, while the thinner blades are for improved airflow.

When you buy a Silent Loop 240mm all-in-one, a pair of Silent Wings fans is included as part of the overall package.

you're replacing your rear fan with something flashier, you can always push the stock fan to the front of the case to pump up the airflow.

(06) Speed control

A topic often debated in the industry, there are pros and cons to both slow and fast fan speeds. A higher RPM (revolutions per minute) produces greater airflow, but is obviously louder. Smaller fans demand a higher RPM in order to work effectively, so don't go for a fan for your case that is smaller than 120mm unless the circumstances demand it, or you're liable to end up with some significant fan noise. An integrated fan control unit can be found in some PC cases. This is a pretty neat feature, enabling you to alter the speeds on the fly with software or an external remote. However, please remember to crank them up when 4K gaming, otherwise you'll end up having a pretty toasty gaming session.

(07) Faces suck

Fan orientation sounds basic enough, but it can be easy to make a small mistake that ends up harming your PC's thermal performance. The majority of fans feature small arrows on the plastic frame indicating the spin direction, and also the direction in which they push air. Another way to check is to look at which side of the fan the power cable protrudes from. When mounting multiple fans on a single section, such as two fans on either side of a heatsink tower, or stacked in the front of your case, make sure they are pumping air in the same direction for maximum efficiency. Since the front face of the fan almost always provides air intake, a nice little trick to remember which way around it should go is to recall the phrase "faces suck."

(08) Cable threading

Good cable management is a lifesaver, especially in smaller and cheaper cases. Install your PSU early on, before the motherboard, and you will be able to pull the cables through first. Space is more precious than gold when it comes to PC building, and if your case has integrated cable management, that's great – this is usually comprised of Velcro straps on the backplate, which help keep the mess out of view. If your case doesn't have this luxury, fear not, because the mighty cable tie will help you out. Don't forget that you can feed smaller cables directly underneath the motherboard before installing it. Cheaper PSUs are likely to come with a bundle of cables you won't be using. Neatly gather these up with a cable tie and store them away, beneath the PSU shroud if your case has one. Out of sight, out of mind (soft of).

(09) Processor cooling

Another crucial part of keeping your system's temperatures down is cooling its brain, the CPU. There are three options for this: a traditional air cooler, full liquid cooling, or an all-in-one (AIO) unit that uses both fans and liquid coolant. The first is typically what comes in the box with your

(10)

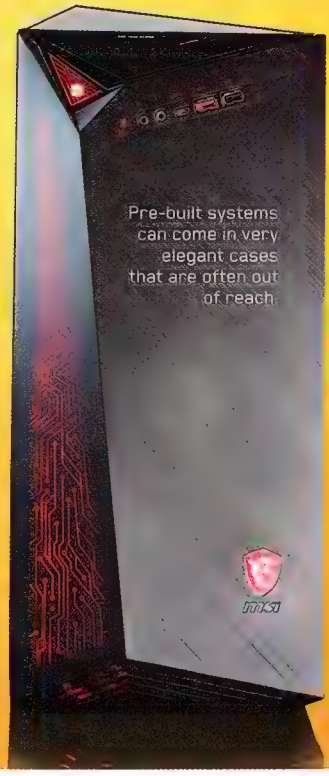
MADE FOR YOU

Right now, trying to scrounge together the parts for a complete new system build can be a nightmare. Some components are still readily available; cases and power supplies aren't selling out like hot cakes, at least. But if you've tried to buy a GPU recently, you'll be well aware that stock shortages and scalpers are proving ruinous to anyone trying to build a home PC. With new cryptocurrencies such as chia starting to threaten SSD stocks, too, the prospect of purchasing a fully equipped pre-built PC starts to look attractive.

Pre-built systems do have some advantages over doing it yourself; guaranteed tidy internals and manufacturer-assured assembly mean that issues such as overheating and component incompatibility are seldom a problem. It can also be a relief to have that catch-all manufacturer guarantee to fall back on if your system fails, rather than having to figure out which component is busted, and determine if you still have a valid warranty.

A pre-built system lacks a few things against custom builds; they're not bespoke, and some contain obstacles to future upgrades, purely by nature of their construction. If you're looking for the ideal purpose-built PC, you're better off taking the leap and assembling it yourself. Manufacturers' ability to bulk-purchase components means that pre-built systems can contain high-end parts at a relatively low premium, though, and there's a degree of assurance that the chosen parts will function optimally together. Many also come with unique cases that can't be obtained elsewhere. These are often compact and aesthetically pleasing, as they can be designed to fit perfectly around the system inside.

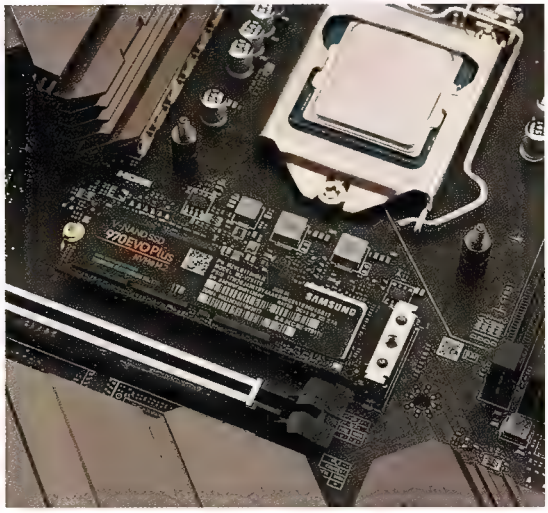
Pre-built systems have come a long way; current offerings from companies such as Aftershock PC and PLE are powerful and effective, although they result in a heftier price point. Higher-end pre-builds are generally a better option, so if you're assembling a PC on a tight budget, DIY is often the way to go. Some companies selling pre-built PCs offer the option to customise your new machine entirely, cherry-picking exactly the parts you want for an additional fee.



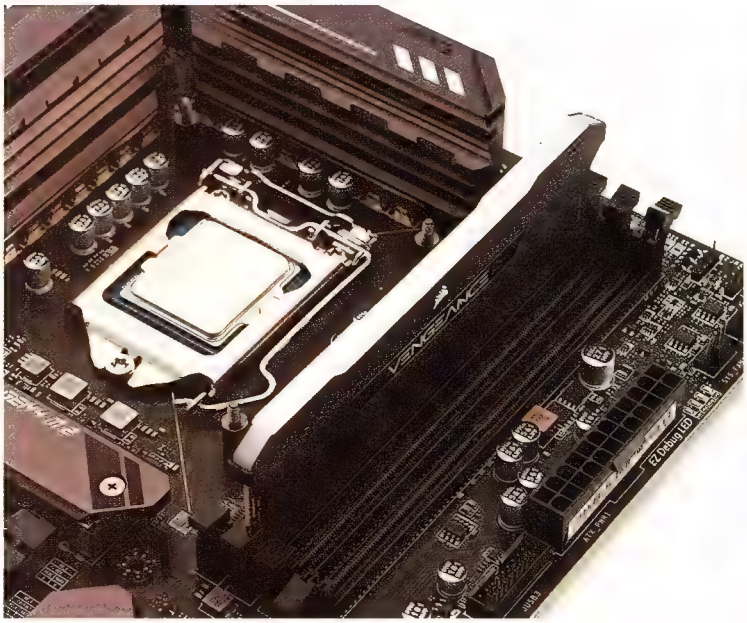
Pre-built systems can come in very elegant cases that are often out of reach

© msi

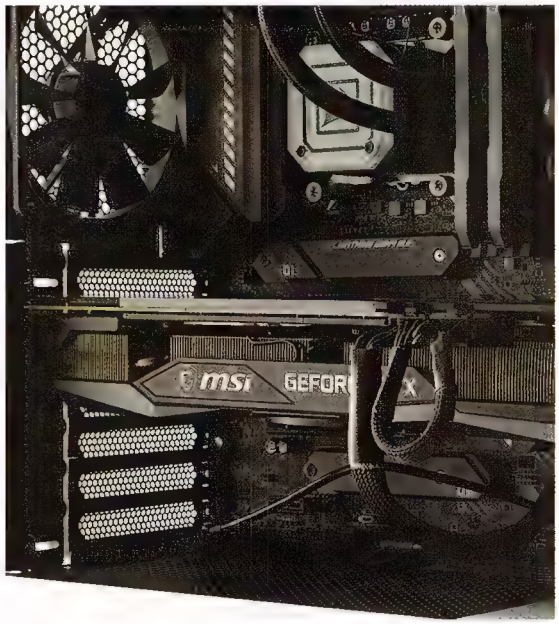
Always make sure the arrows are matching and take your time – CPU pins are super-delicate.



M.2 SSDs are installed directly on to the motherboard; undo the little screw, and slot the drive into position.



Accompanied by a rewarding click, sticks of RAM are very easy to add to your build.



Remove the two PCIe blanking plates from your case before dropping a graphics card into the slot.

processor. These stock coolers are decent enough, and generally not too hard to install, but don't provide high-level cooling. Complete liquid-cooling loops are tricky to install and cost significantly more, but their performance is unparalleled. The best option is generally to go for an AIO cooler. They provide top-notch cooling with a large degree of flexibility, and little to no maintenance. If you're overclocking your CPU, a good AIO cooler is highly recommended.

(11) Air pressure

In any build, you probably want your case to have balanced air pressure. This means that the case draws in air at roughly the same rate that it pumps it out, keeping airflow steady and temperatures lower. Alternately, positive air pressure means your PC draws in more air than it expels – this can prevent air entering through unfiltered sections of the case, potentially reducing dust build-up.

The difference in temperature is relatively minimal, but if you're serious about cooling, balanced air pressure is generally better – test both out using stress-testing benchmarking tools such as Prime95 if you're curious about the results.

There is also a third option – negative air pressure, but you want to avoid this, as it builds up more dust inside your case.

(12) CPU installation

The beating heart of the build, the CPU is the core of what makes your PC tick. The two main central processing unit manufacturers are AMD and Intel. AMD CPUs are a little easier to install; simply lift the retention arm, slot the CPU into place by lining up the gold triangle on one corner with the matching corner on the socket, then lower the arm back into place. All done. Intel CPUs are a tiny bit more complex, with pins mounted on the motherboard rather than the processor itself, and a metal bracket that sits over the CPU socket. Lift the retention arm, then slide the bracket out from under the fixed Torx screw, and raise it to reveal the socket. Line up the CPU and place it in the

socket, then lower the bracket and retention arm back into place. Intel motherboards come with a plastic cover over the CPU socket; this should snap off automatically once the CPU is properly locked in.

(13) Install memory

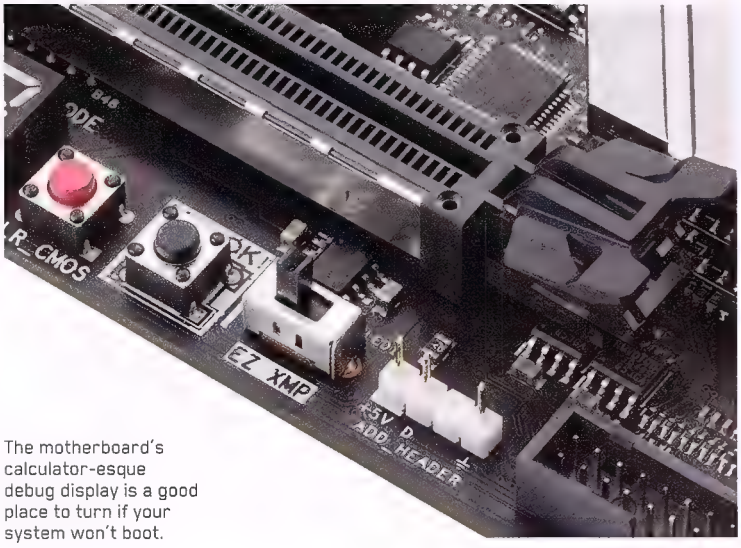
The easiest thing to install on a PC build is probably the RAM. The DIMM slots have either one or two clasps on their short edges; ensure these are open first. The base of the memory stick will have a little notch in it – line it up with the notch in the memory slot, then push it down. It should give a nice satisfying click when it is inserted, with the clasps popping shut automatically. The only thing with RAM installation is that you need to make sure that it goes in the correct slots. They are usually not numbered in order on the board, although they may be colour-coded to indicate which slots use which channels. For dual or quad-channel support to work properly, the RAM needs to be installed in the correct slots. If you're unsure, check the motherboard's manual; it'll let you know exactly which slots to use.

(14) Drive installation

When using a conventional HDD or a 2.5-inch SSD for storage, install it in the case on the relevant mount, then simply run a SATA cable from the drive to the motherboard. Alternately, if you're using a faster and flashier M.2 SSD, things can be a little bit cleaner, by which we mean no cables. Make sure the mounting peg is in the right position for the length of your SSD, then remove the tiny Phillips screw and fit the drive into the slot. You may have to insert the connector end of the SSD first at a 30-degree angle to fit it in securely, then push the drive down gently to screw it in. Many motherboards come equipped with a heatsink for the M.2 drive, which needs to be removed before installation, then secured on top of the drive afterward. Don't forget to remove the protective seal on the heatsink's thermal pad; we've all been there and done that, and it smells like burning, so please avoid the momentary panic.

(15) GPU installation

As it is likely the biggest piece of hardware that will sit on your motherboard, please be careful when installing your graphics card. Along with the sheer size of the majority of GPUs comes the ever-increasing price, so that's just one more reason to treat this step with extra care. Dropping one of these on to a motherboard risks damaging both parts. First remove the expansion slot covers from the rear of your case, then ensure that the clip on the PCIe slot is released. Similar to the RAM slots, it automatically snaps shut when the component is properly inserted. Position the GPU with its I/O in line with the rear of the case, then gently push it down until you hear that satisfying click once again. Secure it to the case with screws straight away. This principle also applies to other PCIe components such as soundcards. For best performance from your graphics card, insert it in the uppermost PCIe slot.



The motherboard's calculator-esque debug display is a good place to turn if your system won't boot.

(16)

RGB or not RGB?

RGB lighting is a topic of much debate at the *APC* office (and on every single computer hardware forum in existence, in fact). It's tempting to use it in your build, though. RGB coolers and fans are becoming more prevalent, so it's easy to be drawn in. And RGB has spread to other components, too, with even power supplies now able to sport a glowing rainbow fan for a few dollars more. Those little additions often add up, though.

A pair of premium maglev case fans from Corsair will run to around 30 dollars, while the company's RGB counterparts cost easily that much for a single fan. Stick-on LED strips aren't too expensive, but can require expansion kits and RGB controllers, which drive up the price if you want to properly synchronise your system's lighting. And, of course, you need a case that shows off your multicoloured lights; that means tempered glass or even pre-installed RGB lighting, which could result in a less than sensible total cost. At the very least, control software for most branded RGB kits is free to download.

A good rule of thumb when it comes to RGB is to simply ask if you could get the same performance for a cheaper price without the lighting. If you're going to spend an extra 50 dollars on a case just because of its glass front, consider how much time you're going to spend looking at your PC against how much time you're going to spend looking at the screen. Putting that money toward a superior monitor is always going to serve you better, especially if you're operating on a budget. But if you've got the money to burn or you come across an RGB component that performs just as well as its same-priced competitors, go right ahead and turn on the rainbow.

© corsair

(17) STAY FROSTY

A full custom liquid cooling loop can be a struggle to get right, but it does come with one major advantage: lower running temperatures, potentially generating more thermal headroom for CPU and GPU overclocking. Fans can be run slower, resulting in less noise compared to pump whine, but if you're running a powerhouse PC that is going to produce a lot of heat, liquid cooling is the way to go. Creating your own loop is a costly process, though, demanding a budget of at least $800 to be done right in most ATX cases.

Planning out the build is absolutely necessary if you're going to be installing coolant tubes in your case. We recommend taking a side-on photograph of your chassis and using your picture editing software of choice to plan out the positioning of your components and tubes, using arrows to ascertain which direction you want the coolant to flow. The larger your case, the easier it becomes; reservoirs and radiators can take up a lot of space, although you're probably going to end up spending more money. Smaller cases may demand the drilling of holes through metal frames to feed through tubing; for this, you'll want a wide-head drill bit designed for use on metals. Angled fittings can remove the need for bending your tubes; while flexible tubing is an option, hard tubing is easier to secure in place and tends to look better in a finished build. If you're really serious, you can use a heat gun to soften and reshape hard tubing to fit your case perfectly, although this can damage the plastic if done incorrectly.

The pump needs to be gravity-fed by a reservoir. When it comes to radiators, a good rule of thumb is to have at least 120mm of radiator space allocated per component being cooled. For example, if you want to connect your CPU and your GPU to the same coolant loop, you're going to want a minimum radiator size of 240mm.

(18) Power On

The first thing to look for if your build won't boot is the motherboard's debug display. Not all mobos have one – it's usually a calculator-esque seven-segment display, although some high-end boards have a small screen for displaying error codes. Take to Google or consult the motherboard manual, and you should be able to find the specific issue. If you're not sure, or your board doesn't have a display, these next few tips should guide you through.

(19) Hurdles

Memory is frequently the issue when it comes to a build that doesn't boot. Of course, we wouldn't wish this on anyone, but it's good to be prepared just in case. If you can access the BIOS, you should be able to see whether the memory is being detected properly by the system. If not, or if the BIOS isn't registering all of the DIMMs properly, try removing your RAM. Check that the sticks are installed in the correct slots; if they are, but it's still not running, give the additional slots a try. As a last resort, try reinserting the GPU and CPU.

(20) EnergycChecks

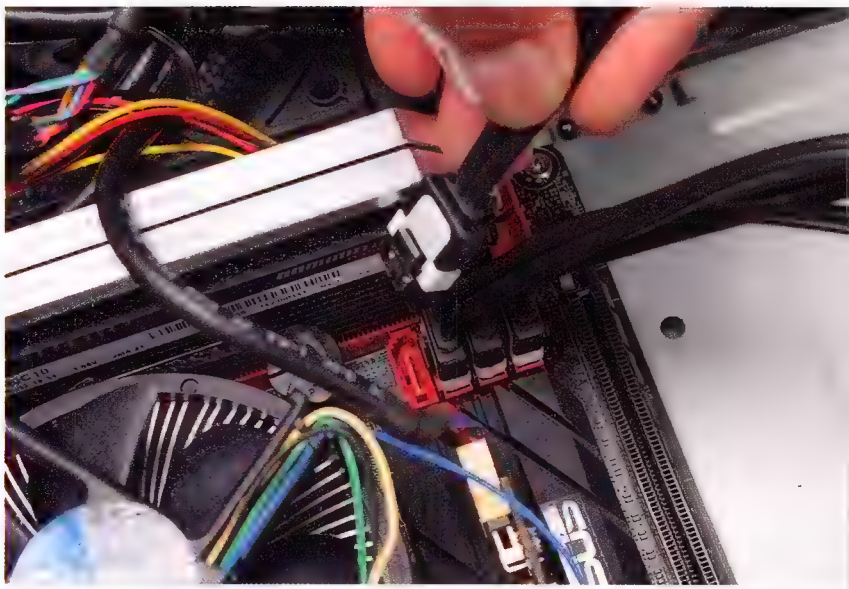
Is everything plugged in? We mean no offense by this question, but we have all been a victim of this problem. The GPU isn't connected to the PSU, the front I/O wires aren't powered, the boot drive isn't plugged in properly, and so on. If everything looks as though it's in the right place and the system is visibly powering up, but you're still staring at a blank screen, try using a different display cable. HDMI and DisplayPort cables are notorious for failing when you need them the most, particularly if you are using cheaper ones.

(21) OS install

Maybe it's not hardware-related, and instead it's software that is causing all this stress at what should be such a happy time – the first boot of your custom-built PC. When transferring an older drive to a new build, there is potential for this issue to rear its ugly head. It's generally caused by existing driver or program conflicts, resulting in a failure to boot. OS files are susceptible to corruption, too. If this is the case, resets and updates aren't likely to resolve the issue. The only option that might fix the problem is to reinstall Windows completely to your boot drive. Unless you're specifically trying to migrate a system to a new case, we recommend installing a fresh copy of your operating system of choice with each new build.

(22) Hardware testing

Components can die. We get it, it's awful and distressing, but it does happen, and it's best to be prepared. If you want to do some final checks before calling the RMA line, you'll probably need a second (functioning) PC. You can test RAM sticks by plugging each one in separately and attempting to boot. With other parts, you can test them on another



Just a single loose cable can lead to your PC not booting.

Tools of the trade If you're going to build PCs, you need the right equipment; these are the key tools you'll want to have close at hand

(23) SCREW BOWL You can splurge on a magnetic bowl for your screws if you want, but any little bowl will do the trick. Even a simple teacup will work. The important thing is to keep all of your screws in the same place when you're working on a rig; they can be easy to lose, and that only leads to frustration.

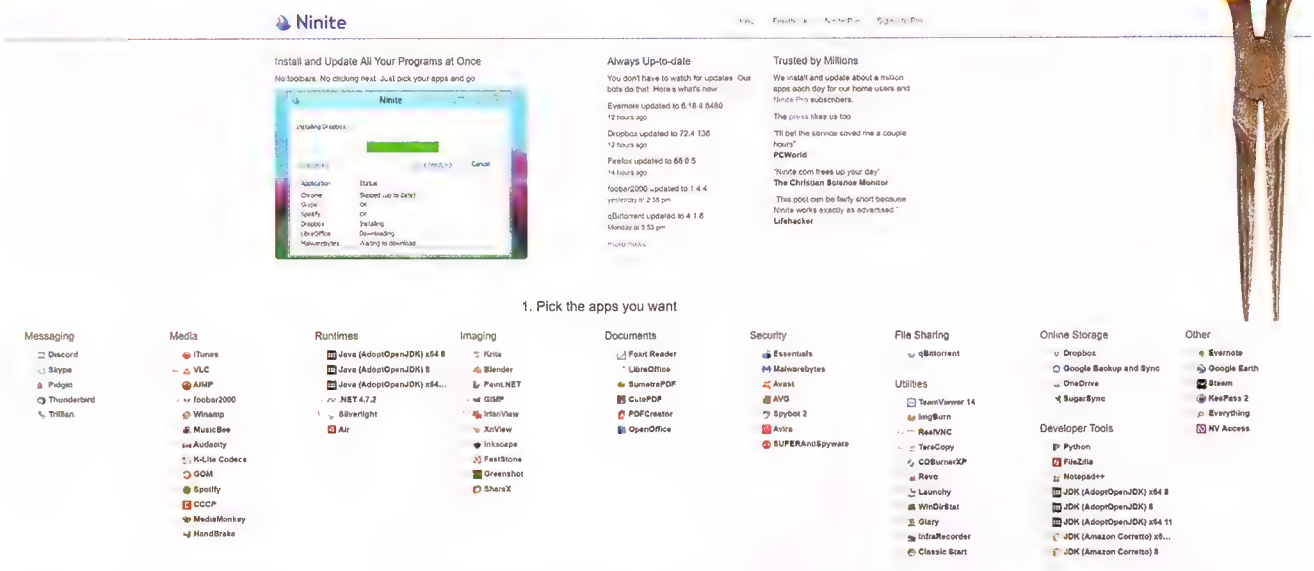
(24) ISOPROPYL ALCOHOL If you're planning on switching out your processor or cooler, you're going to need this stuff. It's inexpensive, and nothing is more effective when it comes to cleaning off dried thermal paste or dirty smudges on metal. As an added bonus, it's one of the few substances that isn't going to kill your components if it spills. As per the warnings on the bottle, handle with care.

(25) THERMAL PASTE Most coolers come with a tube of the manufacturer's own paste, but this can be poor. Our go-to is Noctua's NT-H1; it's not particularly expensive, and Noctua coolers come with some – one tube is good for multiple applications. Remember: You only need a pea-sized dot on normal Intel and AMD CPUs.

(26) CABLE TIES These are vital for any PC-builder. They're dirt cheap and come in a variety of sizes for different uses–in our case, primarily for organising cables. Most chassis have slots on the frame for you to strap down cables, keeping things tidy, and they can also be used for securing bundles of unused power cables from non-modular PSUs to keep your case neat.

(27) SCREWDRIVERS A Phillips-head screwdriver will serve you well in most situations, but a proper driver set is worth the money. Allen screws, tiny M.2 drive screws, and bizarre proprietary screws will all prove frustrating unless you've got the right tool to coerce them loose. Mag-tip screwdrivers are recommended, as they're a godsend when dealing with small screws inside a case.

(28) SPUDGER This little gadget will set you back barely a dollar or two on Amazon, and can come in very handy. Used by the tech-repair pros at iFixit for prying apart stubborn components, its thin plastic edge can also be used to gently realign bent pins on AMD processors.



motherboard in a working system, or replace them with another part you are certain is functioning correctly. Do this with each component in turn (we advise starting with your CPU and GPU), until you identify the part that is causing you grief. While repairing minor damage to individual components can be an option for enthusiasts – such as straightening bent CPU pins – you're best off cashing in the manufacturer's warranty if one of your parts dies.

(29) BIOS update

Updating the BIOS via the internet is supported on most modern motherboards, but if it isn't on yours (or the online update fails to work, which isn't uncommon), you can usually get the update manually from the manufacturer's site. Download it on to an empty USB flash drive – not one filled with your pet pictures – then plug it into the mobo's rear I/O. Within the BIOS's advanced mode, find the update option. Select "Update from storage," locate the file on the memory stick, and you are all set.

(30) Install the OS

If you need a fresh install of Windows 10 for your new build, head straight over to **www.microsoft.com/en-us/software-download/windows10**. Download the Media Creation Tool, and select "Create Installation Media on to a USB drive." Plug said drive into your new build, and then boot it up. If it doesn't work, head into the BIOS and adjust the boot order, setting the flash drive containing the installation media as the priority. From there, just follow the on-screen prompts to set up the operating system and activate your copy of Windows 10.

Ninite is a great one-stop site after your rig is built.

(31) Update drivers

Unless you've been lucky enough to snap up a brand-new GPU on release – and, let's be honest, that ain't happening right now – you're going to want to head over to either the Nvidia or AMD website, and download the most recent driver update. This will ensure that your graphics are running up to speed. If you are using an older motherboard, you may need to update the chipset first. On the manufacturer's website, find your product, then grab the latest drivers, and follow the installation instructions. You might also want some additional drivers here; look for audio and LAN drivers in particular, and remember that the chipset needs to be installed first.

APC's 2019 Dream Machine, filled to the brim with RGB lighting.

(32) Light show

When it comes to installing RGB lighting, ensure that the strips themselves are not directly visible from the windowed side of your case; nobody wants to see that. Light should always be shining on to your components, not out of the case, providing a softer illumination that showcases your build. Find spaces and corners to conceal the lights, either inside the lip of the case's edges or beneath the black border of a tempered glass panel. Using two strips installed at right angles in a corner creates a more even spread of light across your motherboard, but remember that if you're using fully addressable RGB lighting, it's important to make sure that it is all synchronised up properly.

(33) Install software

So, you have a brand-new, custom-built PC, and it may look really fancy, but what's the point if you aren't going to play that scary maze game on it straight away? On a more serious note, you do need to get some software installed in order to get the most out of your new toy. A good one-stop-shop for this is Ninite.com, which enables you to choose from a selection of key programs to quickly and easily download to

© ninite

Knowing your BIOS is crucial if you want to get the very best from your PC.

your C: drive. Ninite also keeps these up to date automatically. If you're a gamer, you'll likely have to do legwork; while Steam is on Ninite's list, other platforms, such as Origin and the Epic launcher, aren't. Similarly, if you use higher-end image or video manipulation software, you'll have to venture out and find this yourself.

(34) RAM settings

Another part you should take a look at is your RAM settings. Double-check that the memory is running at the correct frequency and CAS timings, then enable XMP settings if you're overclocking. You can attempt to manually pump this up, too, but be careful – DRAM voltage increases of more than 10 percent can prove lethal to your sticks.

(35) Colour coding

It's generally best to stick to white lighting unless your setup has a specific theme, and then it's always nice to tie your PC build in with the rest of your room's design. White lighting gives your components a good amount of definition, without drowning out any RGB effects your board is putting out. Bright single-colour LED strips are likely to just highlight the predominant colors on your components, flooding the body's appearance with blue or red. If your strip allows for brightness control, opting for a slightly more conservative light level is a good call. Addressable RGB is great, provided you ensure that you can synchronise to retain an appealing pattern across your entire build.

(36) Use the warranty

If you can't work out what's wrong with your build – or if you can, but you can't fix it – there's one more port of call: the warranty. Most brands come with a decent warranty nowadays, and some components even come with a lifetime guarantee – very generous. Customer service is generally good – if they can't diagnose the issue, you're likely to get a fresh replacement part, provided you haven't done something horribly wrong to the offending component. Don't be afraid to raise a ticket even for minor issues; when it comes down to it, customer services are the experts.

(37) Brand loyalty

Although extended warranties are one of the key reasons we recommend sticking to recognisable brand-name components, you're also more likely to get superior build quality, durability, and longevity. If you're not sure when purchasing, check out the manufacturer's website, and read some reviews on reseller sites. If you can't find many (or any) reviews, tread carefully; don't be lured in by a low price and an obscure manufacturer name. If the product is only available on Amazon, not tech-oriented outlets such as Newegg, be wary.

(38) STOP THE CLOCKS

Overclocking is something to take seriously. If you want to push your hardware to the limit in order to secure additional performance, we strongly advise reading some more in-depth guides on how to do so properly, lest you end up bricking your build. Extreme overclocking beats up the components being used (whether that's a processor, GPU, or memory), which can result in thermal damage to your system if you're not cautious.

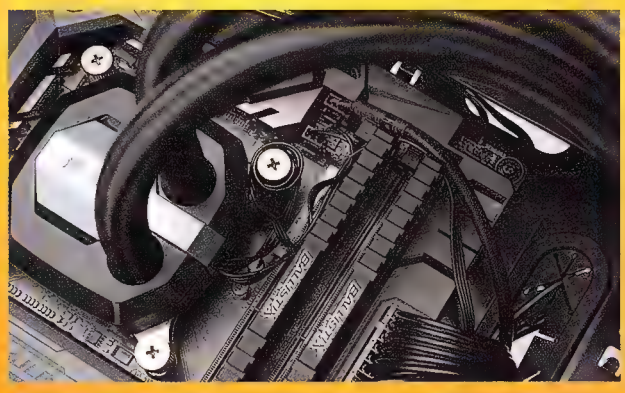
At a fundamental level, CPU overclocking is achieved by raising the frequency at which the processor runs, and raising the voltage supplied to the components to compensate for the additional speed. GPU and memory overclocking works similarly, but we won't get too into that here, as CPU overclocks will likely make the most difference to your PC's performance.

Due to the silicon lottery, CPUs of the same model may have slightly different limits when it comes to the overclocks you can achieve. This is done by accessing the motherboard BIOS and manually raising the frequency at which the CPU will attempt to run. Depending on the capability of the processor, this could be anything from 0.1GHz to 1GHz above the base operating frequency. If you're running a high-end chip, you should be able to squeeze at least 0.5GHz out of it.

Keep raising the operating frequency in small increments in the BIOS, booting and restarting each time. At a certain point, the CPU will refuse to boot. To get past this, head back into the BIOS and raise the voltage, usually by 0.05V at a time. Of course, doing this also raises the temperature, so it's vital to have decent CPU cooling if you're going to overclock–a stock air cooler simply isn't going to cut it, so be sure to splash out on an upgrade.

If you've got a high-end AIO cooler, though, you can use a stress-testing program, such as Prime95, to push your CPU to full resource usage and assess the maximum running temperatures you're likely to hit. Test it between changing the BIOS settings to ensure that you're not in danger of frying your chip.

After a while, you'll hit a stage where it's impossible to get the frequency any higher, regardless of the applied voltage. At this point, dial it back by 0.1GHz to secure a more stable overclock, and run some more benchmarks to ensure it isn't about to die on you. If your PC crashes or you hit temperatures that exceed safe operating levels, lower the frequency by another 0.1GHz, and try, try again.

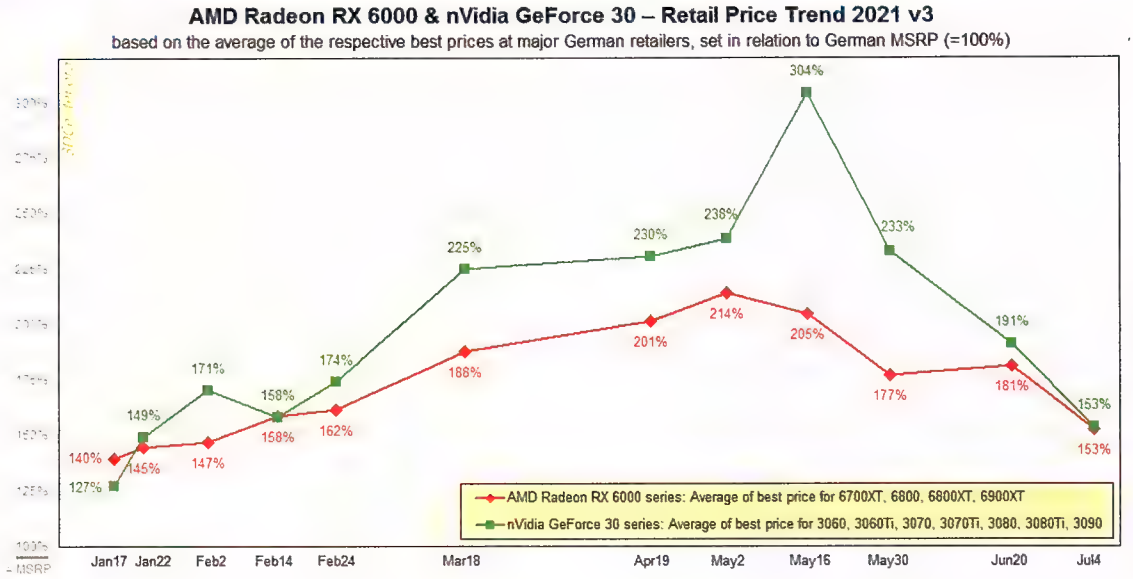


Powerful AIO coolers are a good bet if you plan to overclock your CPU.

© gigabyte

PC BUILDER

WHAT'S HAPPENING IN THE AUSTRALIAN PC MARKET



German retail graphics card average prices have plummeted.

System news

Could China have just fixed the graphics card shortage? Mark Williams investigates.

One of the hardest components to source during the silicon shortage for PC system builders and gamers has been graphics cards. For all of 2021, being able to source the card that you desire has been neigh on impossible, especially at MSRP prices. All models from the top all the way to the bottom were either out of stock or overpriced; often double or triple the launch price.

Well, it seems some relief is being felt in the market, potentially thanks to a move from the Chinese government who, on May 21st, made some big moves to crack down and outlaw once and for all crypto mining and trading in the country.

Why this matters so much is because China was thought to have roughly two thirds of the world's Bitcoin hash rate. While China has made several attempts in the past to clamp down on the practice to little effect, this time around it appears to be succeeding with huge mining farms being shuttered overnight, influencers banned from Weibo en masse and the central bank telling financial institutions to stop citizens from conducting crypto-related transactions.

As a result, the Bitcoin hash rate went from a peak of 190 exa-hashes per second at the start of May down to 65EH/s by the end of June, a reduction of almost exactly two thirds.

With mining and trading now severely curtailed in China, the markets have seen a substantial slump in pricing, with Bitcoin loosing forty seven percent of its value since May. Ethereum, the second largest crypto currency and the one that GPUs are best suited for mining, has seen a 19 percent drop in network hash rate over the same period, suggesting the amount lost was mostly from Chinese miners. Ethereum's value has dropped by over 56 percent over the same period.

MARK WILLIAMS
Mark is an IT professional with a strong interest in voiding warranties.

As a result, many Chinese miners are flooding the local market with their used graphics cards at close to MSRP prices to recoup sunk investments, something that has hasn't happened since Nvidia launched its RTX 3000 series at the end of last year. This appears to be having quite the cooling effect on the GPU market, with second-hand prices now starting to trend downwards for the first time in over a year.

With Chinese GPU demand curtailed, and an excess of used current-gen parts in the local market, GPU manufacturing world-wide appears to now be making some headway to satiating the pent-up global demand.

Average German retail prices for Nvidia cards have halved since May, with AMD cards reducing by a quarter in the same period; both now sit just over fifty percent above MSRP. A substantial drop.

Locally in Australia retail prices haven't seen much change just yet, but we're certainly seeing a lot more availability of SKUs up and down the product stacks. RTX 3080s were the worst for availability but can now actually be found in stock to order. Months ago, they were impossible to find. Even newer SKUs like the 3080 Ti and 3060 Ti can now be found. Sure, you'll pay a premium but if you need one at least you can get one.

As markets continue to fall, miners world-wide are now facing a situation where they can't mine fast enough to make up for the ever-depreciating value of their graphics cards. Meaning they're now more likely to sell their hardware before they lose too much of the investment.

With Ethereum switching towards the end of the year from proof-of-stake (a very GPU compute-intensive task) to instead a proof-of-work model – which is relatively light on compute power – the current largest cryptocurrency for GPU mining will no longer be profitable, meaning this downward trend should continue or even pick up pace.

While graphics card prices are remaining excessively high in Australia, we them to start to drop over the coming months as supply starts to exceed demand. There is finally light at the end of the tunnel!

Market snapshot

A sampling of PC systems available this month.

$1,949 | tinyurl.com/APC497SCO

Scorptec Computers Ryzen RTX 2060

Last gen parts at a premium, here. Unfortunately, this is the world we live in currently, with shortages aplenty. Being only $50 more than the PCCG Void system, though it offers substantially better bang for your buck. If you're looking for a good deal on what goes for an "entry"-level gaming system these days, this isn't too bad given the current market. The venerable Ryzen 5 3600 shouldn't bottleneck gaming performance much so long as you're not running at higher visual quality or resolutions to keep the GPU stressed. If you're looking for peak FPS in eSport titles it will still satisfy most. The RTX 2060 is interesting; it still performs well and offers all those RTX features we love.

CPU: AMD Ryzen 5 3600 **Cooler:** OEM **Motherboard:** Gigabyte Aorus B450 Pro WIFI **Graphics:** Gigabyte GeForce RTX 2060 6GB **Memory:** Corsair Vengeance LPX 16GB 3000MHz DDR4 **Storage:** Western Digital Blue SN550 500GB M.2 SSD, Seagate BarraCuda 2TB HDD **PSU:** Silverstone Essential 550W **Case:** Thermaltake Level 20 MT ARGB.

$1,899 | tinyurl.com/APC497PCC

PC Case Gear Void 1660 Super

Don't let the eye-catching infinity glass on the front of PCCG's Void computer suck you in. This system, despite being priced near the entry of gaming PCs currently, isn't great value for money. The global chip shortage has made sure of that. Housing a CPU that is now two generations and over three years old, this shouldn't really exist in retail, but these days beggars can't be choosers. At least its 6-cores and 12-threads will keep up with most modern games and tasks. However, similarly priced Intel 10400F systems from PCCG offer 10-20 percent more performance out of the box. Being on the AM4 platform though you can spend a minimum now and upgrade later to Ryzen 5000 should you feel the need.

CPU: AMD Ryzen 5 2600 **Cooler:** OEM **Motherboard:** MSI B450M Mortar Max **Graphics:** PNY GeForce GTX 1660 Super 6GB **Memory:** Team T-Force Delta RGB 16GB 3200MHz CL16 DDR4 **Storage:** PNY CS900 2.5in SATA SSD 500GB, Seagate Barracuda 2TB HDD **PSU:** Kolink Modular Power Bronze 600W **Case:** Kolink Void RGB.

$5,198 | tinyurl.com/APC497PLE

PLE Sub-Zero

While other computers around this price may be a little better fitted out with higher end components, they likely won't be anywhere near as fun as this system if you are into overclocking. Using a Thermoelectric cooler (TEC) water cooler hybrid on top of Intel's latest 8-core processor, using the Peltier effect it allows for sub ambient temperatures to be achieved, which unlocks all sorts of exciting potential when playing around with overclocking, but also potential drawbacks in the form of condensation (which the unit can self-manage if desired) as well as extra power draw. The cooler alone can draw up to 200W! The beefy PSU will keep everything humming along nicely even when pushing the system to its extremes.

CPU: Intel Core i7 11700K **Cooler:** Cooler Master MasterLiquid ML360 Sub-Zero AIO **Motherboard:** MSI MAG Z590 Torpedo **Graphics:** ZOTAC GAMING GeForce RTX 3070 Ti AMP Holo 8GB **Memory:** GeIL 16GB Orion RGB Grey C16 3200MHz DDR4 **Storage:** Samsung 980 Pro 1TB M.2 NVMe SSD, Seagate BarraCuda 2TB HDD **PSU:** Cooler Master V 1000W **Case:** Cooler Master Cosmos C700M RGB.

$5,585 | tinyurl.com/APC497AFT

Aftershock PC Explorer

Is your house starting to feel a little tired while constantly working from home thanks to COVID lockdowns? This stunning showpiece will brighten any room. Both Beauty and Beast, it looks great while packing quite a gaming performance punch. The 5600X is one of the best gaming CPU's around at the moment and matched with a GTX 3080 you'll be hard pressed to find a better performing combination without spending substantially more. The very speedy RAM will keep the CPU happily fed. Mass storage is adequate, though a tad anaemic for this price point, and the PSU will afford much upgradability and overclocking opportunities. A machine that is worthy of showing off to all your friends... when the lockdowns end of course.

CPU: AMD RYZEN 5 5600X **Cooler:** Custom open loop water-cooling with hard-line acrylic tubing **Motherboard:** GIGABYTE B550 VISION D-P with WIFI **Graphics:** GIGABYTE 3080 GAMING OC 10GB **Memory:** 16GB Gigabyte Aorus RGB DDR4 3733MHz **Storage:** 512GB AFTERSHOCK M.2 NVME SSD, 1TB 7200RPM HDD **PSU:** MSI MPG A850GF 850W **Case**: Thermaltake Core P3.

BLUEPRINTS

VALUE- AND PERFORMANCE-DRIVEN HYPOTHETICAL BUILDS

PC BUILDER

Budget

Good.

Another month, another depressing set of GPU prices across all the major online retailers. Even worse, it seems that prices of budget CPUs are rising, too, with AMD's Athlon 3000G rising by a small amount and Intel's i3-10100 leaping up by more than a third. It's dispiriting, but there aren't many good alternatives; if you're considering getting an i3 right now, the 10300 is only 30 or so dollars more than the 10100, and offers significantly better performance. There aren't really any good alternatives to the AMD chip, as we're seeing low stock on processors such as the Athlon 240GE.

Both our budget builds this month have new motherboards: Gigabyte's wallet-friendly offerings for AMD and Intel respectively, the B450M and B460M DS3H V2. They're straightforward mATX mobos, devoid of flashy but expensive RGB lighting or similar fancy features. They're also some of the most affordable boards available right now, so props to Gigabyte for making them an easy choice.

We've done something similar with the RAM for these two builds, too. These are both 2x 8GB kits from GeIL at 3,000MHz; GeIL isn't one of the big-name brands when it comes to memory, but you're ultimately often just paying for the same chips (from Hynix, Micron, and so on) with a different company name slapped on the side. The Evo Spear and Orion kits from GeIL are perfectly good components available for cheap, although we do admit that they're pretty ugly in comparison to memory from Corsair or Crucial.

There wasn't much else that needed changing in the budget builds, with prices rising subtly across the board but few opportunities to scrimp and save. We did swap out the SSD in our Intel build, opting for XPG's gaming-oriented Gammix S5 drive, which kept our costs steady without much change in performance. Samsung still has pretty much the only good PCIe 4.0 SSD in the 250GB range, so the AMD build doesn't get a new drive.

AMD INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$110
PSU	500W EVGA BR 80+ BRONZE	$90
M/BOARD	GIGABYTE B450M DS3H V2 **NEW**	$110
CPU	AMD ATHLON 3000G	$140
GPU	AMD RADEON RX 6700 XT 12GB	$1,200
RAM	16GB (2X 8GB) GEIL ORION @ 3,000MHZ **NEW**	$140
SSD	250GB SAMSUNG 980 PRO M.2 PCIE 4.0	$110
HDD	1TB WD BLUE 1TB 7200	$60
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$2,020**

INTEL INGREDIENTS

PART		PRICE
CASE	CORSAIR 4000D AIRFLOW	$110
PSU	500W EVGA BR 80+ BRONZE	$90
M/BOARD	GIGABYTE B460M DS3H V2 **NEW**	$110
CPU	INTEL CORE I3-10100	$130
GPU	NVIDIA GEFORCE RTX 3060 12GB	$900
RAM	16GB (2X 8GB) GEIL EVO SPEAR PHANTOM GAMING @ 3,000MHZ **NEW**	$130
SSD	256GB XPG GAMMIX S5 M.2 PCIE 3.0 **NEW**	$65
HDD	1TB WD BLUE 1TB 7200	$60
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$1,655**

PC BUILDER

Mid-range

Better.

It's time for a processor upgrade! The 3000-series Ryzen chips are becoming more scarce, to the point where a shiny AMD 5000-series CPU is starting to look like an excellent alternative. As such, we've gone for the Ryzen 5 5600X, which offers a performance boost in the range of 15 percent over the 3600X it replaces, all for a very modest rise in price. As it's far newer, too, this build is now more future-proof than ever. Mind you, a new AM5 motherboard will likely be the order of the day once the next chipset generation for AMD lands next year.

The Intel system doesn't get any such upgrade (as it already has an 11th-gen Core processor) but it does get a new motherboard, the Z590M PRO4 from Asrock. At $220, it's reasonably priced for a Z590 board, and it comes with RGB lighting and a heat shield for your M.2 drive (although the Gigabyte Aorus M.2 SSD can be bought with its own chunky heatsink). We toyed with the idea of changing up the cooling solutions for these two machines, but found we were already getting the best value for money with our existing AIOs.

The Intel rig also gets new memory courtesy of Silicon Power, a Taiwanese company better known for its flash drives and card readers. The Xpower Turbine memory is a solid proposition, though, at a sensible price, with performance that comfortably hits the industry standards. A broad gamut of user reviews indicate that Silicon Power's memory is no less long-lasting and effective than RAM from household-name brands.

Back in the AMD mid-range build, we've got a new PSU and SSD. The power supply is from a range we've recommended before; Fractal Design's excellent Ion Gold model, also seen here at a higher wattage in the AMD turbo build. The drive is a newcomer; PNY has broken into the PCIe 4.0 SSD market with its XLR8 range of M.2 drives, of which we're using the CS3040.

AMD INGREDIENTS

PART		PRICE
CASE	LIAN LI PC-O11-DYNAMIC	$200
PSU	650W FRACTAL DESIGN ION GOLD **NEW**	$150
M/BOARD	MSI MPG X570 GAMING PLUS	$230
CPU	AMD RYZEN 5 5600X **NEW**	$430
COOLER	240MM COOLER MASTER MASTERLIQUID ML240L RGB	$100
GPU	NVIDIA GEFORCE RTX 3070 8GB	$1,600
RAM	16GB (2X 8GB) TEAM T-FORCE VULCAN TUF @ 3,600MHZ	$160
SSD	500GB PNY XLR8 CS3040 M.2 PCIE 4.0 **NEW**	$140
HDD	1TB WD BLUE 1TB 7200	$60
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$3,130**

INTEL INGREDIENTS

PART		PRICE
CASE	LIAN LI PC-O11-DYNAMIC	$200
PSU	650W EVGA SUPERNOVA 650 GA	$120
M/BOARD	ASROCK Z590M PRO4 **NEW**	$220
CPU	INTEL CORE I7-11700K	$500
COOLER	ENERMAX LIQMAX III 240 RGB	$90
GPU	AMD RADEON RX 6800 XT 16GB	$1,800
RAM	16GB (2X 8GB) SILICON POWER XPOWER TURBINE @ 3,600MHZ **NEW**	$155
SSD	500GB GIGABYTE AORUS M.2 PCIE 4.0	$130
HDD	1TB WD BLUE 1TB 7200	$60
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$3,135**

PC BUILDER

Turbo

Best.

Prices on our AMD system have been falling across the board (minus the GPU, obviously), so there were precious few meaningful changes to be made. We did nab a new motherboard, Gigabyte's X570 Aorus Elite Wi-Fi, and a new SSD. PCIe 4.0 drives are getting more affordable, with Corsair and Sabrent both releasing more wallet-friendly variants of their MP600 and Rocket 4 drives, but we've gone with Team Group's reliable Cardea Zero Z440 drive.

Our high-end Intel machine has seen a lot more changes. That MSI cooler isn't the only RGB lighting we'll be blinging up this system with, as we've got a 32GB kit of G.Skill's TridentZ RGB memory to further illuminate the guts of that Enthoo Pro 2. We've also got a new PSU, as EVGA's SuperNOVA 750 G5 is currently a good price, making it a killer deal given EVGA's product quality.

The big shift here is the CPU. This turbo rig no longer lags a generation behind its mid-range counterpart, as we're finally upgrading to the Intel Core i9-11900K. Team Blue's new flagship chip is a powerhouse, and as the i9-10900K is no longer significantly cheaper than its successor, it made sense to make the leap.

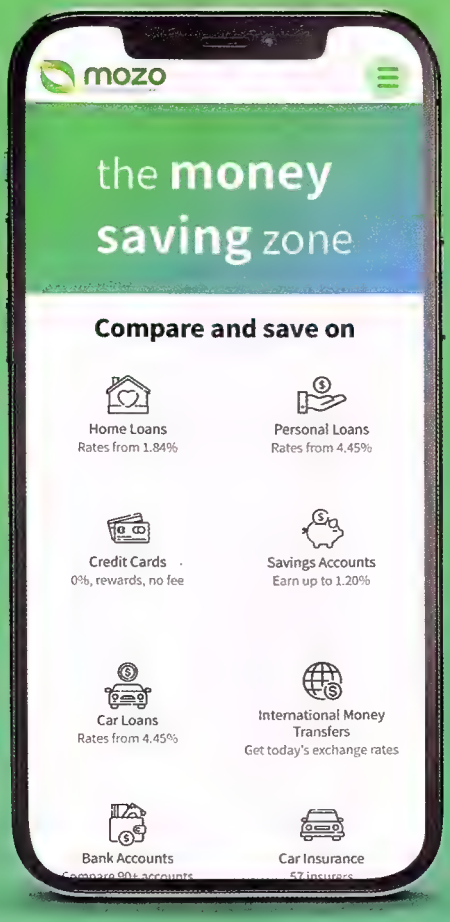
The i9-11900K had a slow start, with software compatibility issues hindering performance against its predecessor, but it's now in a reasonably good place (about 10 percent above the 10900K in most tests) and offers PCIe 4.0 support. That means we're getting a new drive in both turbo systems. The Intel rig gets Seagate's slightly pricier 1TB FireCuda 520, stated to last for up to a whopping 5,600TB of writes. Unless you're doing some really insane file transfers on a daily basis, we can't see how it would ever give out on you.

AMD INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$220
PSU	750W FRACTAL DESIGN ION GOLD 80+ GOLD	$170
M/BOARD	GIGABYTE X570 AORUS ELITE WI-FI **NEW**	$260
CPU	AMD RYZEN 7 5800X	$630
COOLER	FRACTAL DESIGN CELSIUS S36 360MM	$250
GPU	NVIDIA GEFORCE RTX 3080 10GB	$2,300
RAM	32GB (2X 16GB) PATRIOT VIPER STEEL DDR4 @ 3,600MHZ	$300
SSD	1TB TEAM T-FORCE CARDEA ZERO Z440 M.2 PCIE 4.0 **NEW**	$150
HDD	6TB WESTERN DIGITAL BLUE	$240
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$4,580**

INTEL INGREDIENTS

PART		PRICE
CASE	PHANTEKS ENTHOO PRO 2 TEMPERED GLASS	$150
PSU	750W EVGA SUPERNOVA 750 G5 **NEW**	$170
M/BOARD	MSI Z590 PRO WIFI	$280
CPU	INTEL CORE I9-11900K **NEW**	$700
COOLER	MSI MAG CORELIQUID 360R AIO **NEW**	$170
GPU	AMD RADEON RX 6900 XT 16GB	$2,200
RAM	32GB (2X 16GB) G.SKILL TRIDENTZ RGB @ 3,600MHZ **NEW**	$340
SSD	1TB SEAGATE FIRECUDA 520 M.2 PCIE 4.0 **NEW**	$280
HDD	6TB WESTERN DIGITAL BLUE	$240
OS	WINDOWS 10 HOME 64-BIT OEM	$60
PRICE:		**$4,590**



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QUICK TIPS

APC experts solve computing problems

The *APC* team tackle problems across the spectrum of devices and software. Learn a new trick or fix you can use.

No Store downloads

My current problem is with the Microsoft Store. Having read somewhere (I think) that some future Windows 10 updates will be coming through the Store, and having discovered my Calculator app had stopped working some time ago, I thought I'd remove it and reinstall it from the Store. But while it comes up OK, whenever I click the "Get" button, nothing happens.

I've tried running WSreset.exe, which didn't fix things, and have tried resetting the Store under "Settings > Apps > Microsoft Store > Advanced Options," but still no change. I've also tried PowerShell commands – which I was able to verify had removed and reinstalled the Store – but that made no difference either. I've also tried signing out of my Microsoft Account and back in, but to no avail. The Store runs fine on my laptop, so I'm running out of things to try.

GERRY EXSTEIN

APC responds: Ah, the Microsoft Store – bane of many a Windows user. OK, you've performed the basic repair steps, so next we need to widen the search for corrupt files: Right-click the "Start" button, open "Command Prompt (Admin)," and issue this command:

```
sfc /scannow
```

If errors are found, let it fix them and run the scan again. If it fails to resolve the problem, try DISM instead:

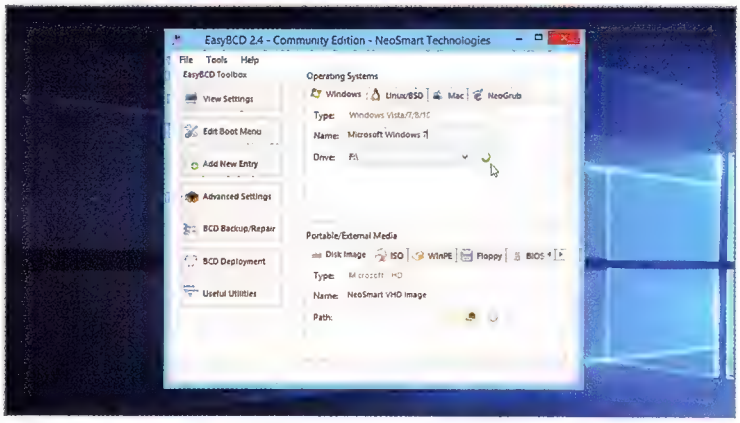
```
dism /online /cleanup-image /checkhealth
```

The check should complete in seconds on a fast machine. If problems are found, download the Media Creation Tool (www.microsoft.com/en-us/software-download/windows10/). Use this to create new Windows installation media, then make a note of the drive letter assigned to your media before issuing the following command, substituting the "X" with said drive letter:

```
dism /online /cleanup-image /restorehealth /source:WIM:X:\sources\install.wim:1
```

If this also fails, you're entering repair or reinstall territory. If the rest of your Windows installation is performing OK, ask yourself if you really need the Microsoft Store. There are plenty of non-Store alternatives to the Calculator app, such as Kalkules (**www.kalkules.com**), while Windows updates will continue to be delivered in the usual manner via its own Updates tool.

If you want to take things further, open the Windows Media Creation tool again, but choose "Upgrade this PC now" to perform the repair install, which is your final chance of fixing the problem without resorting to the nuclear option. And we say it again, is the Store really worth it? *APC* thinks not….



Remove unwanted dual-boot entries with EasyBCD.

Boot problems

I have a nine-year-old machine, which was state of the art when I built it in 2012. After having Win 10 installed alongside Win 7 in a dual-boot capacity, I've started to encounter two problems: First, it occasionally becomes very slow to respond to user input; and second, when I reboot to get rid of the problem, the BIOS refuses to boot into Windows 10 with the error message "A required device isn't connected or can't be accessed." The problem is temporarily fixed by booting into Windows 7, then running chkdsk on all the drives, but then it comes back again. I'd appreciate any help you can give me.

ALAN DARLINGTON

APC responds: Alan gave us a blow-by-blow account of his troubleshooting steps, as well as a detailed summary of his system. One extra piece of information he supplied was that his motherboard (Asus P8Z77-V Deluxe) came with a Lite-On 32GB mSATA SSD drive. It's this drive that we suspect may be at the root of Alan's woes. It is intended to act as a fast cache using Intel's Rapid Storage Technology (RST) utility, but is technically redundant now that Alan has installed SSD boot drives throughout his system.

The drive is problematic because it's the sole reason Alan still has a dual-boot machine, and the error he's getting on trying to reboot Windows is a classic symptom of problems with the boot configuration data (BCD), stored in the EFI system partition created on the drive where you installed your first OS – in Alan's case, Win 7.

When Alan asked his local computer store to update from Win 8 to Win 10 in January 2021, the system installer had wanted to replace his dual-boot configuration with a single Win 10 installation. He'd planned to disconnect all drives except the Win 10 drive, to ensure the installer created a new EFI system partition on the drive instead of simply updating the Win 7 EFI

system partition. However, he decided the mSATA SSD drive was too difficult to remove, so "made do" by installing Windows 10 alongside Windows 7.

We suspect Alan's issues can be fixed by following the system installer's original plan. We're not sure why he shied away from removing the mSATA SSD drive – it's just screwed into the motherboard and is easy to remove. Once done, you can unplug all the other drives except for the one you plan to install Win 10 on, boot from your installation media, and make sure you delete all partitions on the drive during the install process – it then creates the required boot partitions alongside Win 10 and provides a single-boot setup that should work going forward.

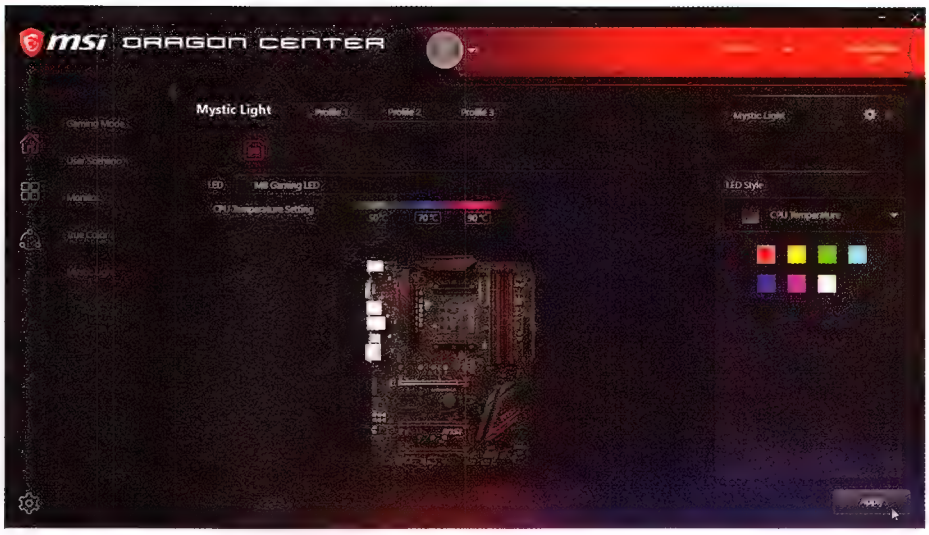
If Alan wants to continue using Win 7, he needs to configure the Win 10 drive as the first boot device in the BIOS, switching between the two at startup by tapping F8 to bring up the BIOS boot menu. After booting into Win 7 for the first time, we recommend using a tool such as EasyBCD (**https://neosmart.net/EasyBCD**) to remove the redundant (and non-working) Win 10 option from its EFI system partition.

One final thing: This, of course, involves reinstalling Win 10 from scratch, so make sure you've backed everything up before you begin. Treat this as an opportunity to wipe clean and get things properly in order going forward.

Lighting setup issues

I've completed my first custom build in a long time, with a lot of new components. I have a Corsair iCUE 5000x RGB case, with the included Corsair PWM and LNC. I added a Corsair Commander Pro. I built that up with an Asus ROG Crosshair Hero VIII, Phanteks Glacier One 240 MPH AIO, and added a Corsair QL 120 RGB rear exhaust fan, and two Corsair QL RGB 140mm top fans.

The problem is that I'm unable to get the RGB working on any of the fans. I've tried several iterations of connections to the mobo and LNC and Commander Pro, all to no avail. The fans all spin just fine, and I have all the necessary connector cables, but I can't seem to get the RGB part working. I need some guidance please.
DAVE COBB



Not all lighting systems are compatible with each other.

APC responds: The world of lighting is exciting and confusing. Before embarking on setting up your first lighting rig, the APC recommends reading this beginner's guide from Reddit: **www.reddit.com/r/buildapc/comments/ku117m/a_beginners_guide_to_rgb_in_2021/**. The crucial point is that many solutions are proprietary and won't work with each other. That means you can't connect the Phanteks Glacier One to the LNC to control the lights. Thankfully, all is not lost, as you can connect it directly to your motherboard, so use the supplied three-pin D-RGB motherboard adapter to connect the cooler to one of the Addressable Gen2 LED connectors (see the manual for placement details). It should light up when you power on, confirming it's connected correctly.

You'd think removing this from the equation would mean the QL fans would work with your setup, but no. QL fans are a different type from the three SP RGB Elite fans included with the Corsair 5000x case, so can't be connected to the same controller. You need to connect the QLs to their own Corsair RGB fan LED hub (see **www.corsair.com/us/en/Categories/Products/Custom-Cooling/Accessories/CORSAIR-RGB-Fan-LED-Hub/p/CO-8950020** for details), which plugs into one of the spare LED channels on the Commander Pro.

Again, when connected correctly, you should find the first fan in each sequence lights up when you boot. Now install both Asus Aura from the "Support" section of your motherboard's page on the Asus website and the latest version of iCUE, then link them using Corsair's guide (**https://help.corsair.com/hc/en-us/articles/360041797351**) to get all the fans working in unison.

Explorer resets

I've got a bizarre behavior going on with a new PC I built: Windows crashes but doesn't blue screen; instead, what I'm guessing is Explorer.exe blinks out, resets, and then Windows tries to move on. I don't get a dump file or a crash code. Instead, all my browser tabs crash and any game I'm playing force quits. I see no evidence of overheating, and tested each RAM stick. The GPU was from a previous stable build. I've tested my m.2 drive with Samsung's software and it's marked healthy. Is there any chance this new form of Windows reset is generating a dump that has more clues?
TZVI SHERMAN

APC responds: The problem you're seeing is more likely to be software-related. Is there any pattern to the bad behavior? For example, does it crash when you right-click in File Explorer? If you can trace the start of the problem to a specific incident – such as app installation (or update), you have something to work from.

Also look at Event Viewer: type "event" into the Search box to open it. A summary appears – any Explorer reset is likely to appear under "Error" or "Warning," so expand each and browse through the list looking for any likely events linked to your problem. Double-click one for more details, including a date and timestamp of when it occurred, which may help identify the issue. Use the information to hopefully learn more and find a fix. ■

Build a better liquid-cooled setup

Doing a proper job, with Kris Butterill.

Water cooling a PC can be a daunting task for those new to the scene, and at times, even for some seasoned professionals, but where do you start if you want to take your build to the next level? Running a custom water cooling solution does bring a number of benefits, extending the life of the hardware, being able to have a virtually silent system, allowing for higher overclocks, stable temperatures, and much more.

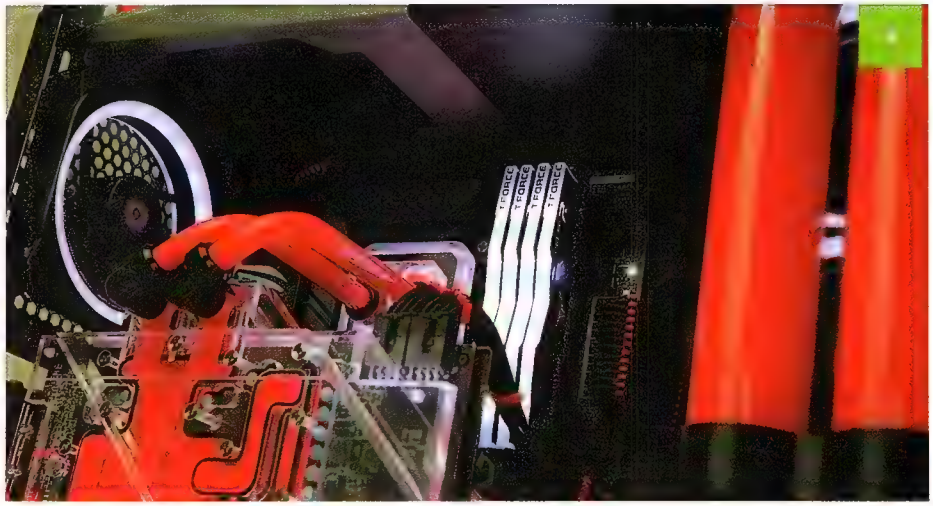
Now, builds usually fall into one of two use cases: those that purely focus on productivity, and enthusiast or gaming setups. Both situations are, of course, first and foremost, dictated by the hardware to be used, and the performance required for each scenario. Productivity builds can obviously take advantage of the benefits that water cooling can bring, but in most cases, aesthetics are not a factor in the decision-making process. Enthusiast or gaming systems are a different beast, though – people want to show off their systems, it's part of the PC gaming journey. We are not talking about an AIO being slapped in a case; no, we are talking hard lines, pumps, reservoirs, and much, much more.

Here, we're covering some of the little things you should know, what to look out for when building a water-cooled system, and the options available before embarking on an adventure into the world of PC hydration.

Preparation

The most important step in any build, let alone a water cooling project. Plan, research, and measure.... Then do it again.

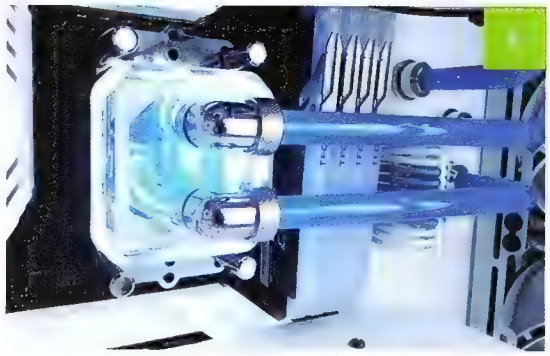
Decide on the key components for your use case first, and build around that – this is the priority and dictates everything else. At this stage, don't think about the water cooling side too much, just bear it in mind and ensure that whatever case, CPU, motherboard, and graphics card you will be using are suitable and compatible for water cooling. Your case choice will have a massive impact on what can be supported – an ITX case for a full custom loop is going to be challenging, to say the least. Give yourself some room to maneuver, especially for a first attempt. Consider the case airflow, mounting options for radiators, pumps, and reservoirs. You might end up going back over and revising the case choice, for example, but if you end up revising hardware to fit the cooling, then it's time to rethink. Cooling is there to support the hardware, not the other way around.



YOU'LL NEED
A system to build
Plus water-cooling parts, bending kit, hand tools, imagination, and perseverance.

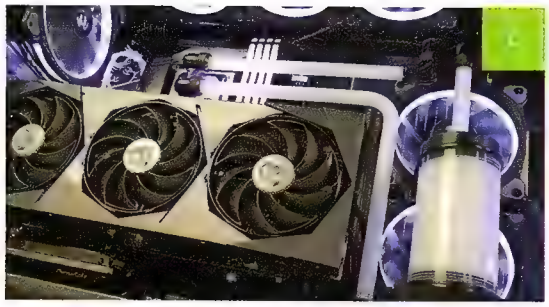
Planning

Once you decide on the hardware, it's time to decide on the cooling specification. Are the water cooling parts you have in mind adequate and suitable for what you need? It's no good running a 10900K and an RTX 3090 on a single 120mm radiator. The rule of thumb is to have at least one 120mm or 140mm section per component, plus an additional section, so at least a 360mm/420mm radiator for a simple solution. Loop order can be debated all day long, but for most scenarios, it's not hugely important. Provided that the pump is located with a gravity-fed supply of coolant to prevent it from running dry, don't worry about it too much. Preferably, this will come from a reservoir, but it can be from a radiator or even a block.



Will the system run in series, parallel, or even a dual loop? Series loops are the most common; just make sure that it's planned using the "In" and "Out" ports for CPU, GPU, and pumps. Parallel loops are less common; but can be used if space is a little tight, or you want a different look, while dual loops separate the CPU and GPU – however, it means at least two pumps, reservoirs, radiators, sets of fans, and power connections, making them more complicated than needed, unless aesthetics are the goal. Parallel runs offer a more minimalist option [Image A].

Drawing the loop on a piece of paper can really help visualise the layout and flow direction – think about access to fill and drain the system, and placement of the components. It's also time to think about what type of tubing you want to use: soft or hard. If this is your first go, our advice is to go for soft tubing. This makes it easier to put together, but will help build



your confidence before attempting custom-bent hard line. It's also not too difficult to convert to hard line, too – the only thing to change out are the actual fittings, and it can be done later down the road.

Finally, do you have everything you need, in terms of equipment and tools? A bending kit is great for hard-line runs, a sharp blade for soft tubing, a heat gun, files, pipe cutters; they can all potentially add more cost to a build. For simple 90-degree hard-line runs, there are pre-bent options available from the likes of EKWB and Alphacool, with most manufacturers also offering complete bending kits, too.

Parts

Water cooling isn't cheap – at a minimum, you are going to need a pump, reservoir or combo, radiator, CPU and/or GPU block, fittings, and pipe. Fittings soon add up, and so does the cost, so making sure you get the correct parts is essential. The most common type of thread is G1/4, with fittings available in a range of diameters – 10mm/13mm being a popular option. Ensure that everything you add to your basket is in the same sizes to prevent disappointment. In terms of making your build look unique, if you planned it well and researched the available parts, there are some great options. Pass-through, or bulkhead fittings as they are known, are great if you want to hide something away – for example, a pump under a PSU basement shroud. They can also help to run connections out of sight for a minimalist look [Image B].

Forty-five-degree connectors, multiport blocks, extenders, double-angle connectors, hard-line fittings, soft-tubing fittings; there's a myriad of options, with thousands of combinations. Distro plates are also now becoming more common, especially with cases such as the Lian-Li 011 Dynamic being such a huge hit. When you are picking fittings and connectors, always expect to place a second order. Quite often, no matter how much you plan and measure, there will be that one connection that could do with another 2cm clearance, or bend.

Trial and error

Now the hard part is putting it all together. For hard-line systems especially, use one type of fitting and you end up having a complicated multi- bend run to the next component. Change out the fitting type, add an extender, or move the placement of the component slightly, and it becomes a simple run. Using multiple fittings to simplify a bend also helps make tubing runs easier [Image C]. This can be a long-winded process, especially if you don't have a load of parts lying around just to try, but it really is worth taking extra time here. Remember not to overtighten fittings, and remove the protective film from CPU blocks – it happens more often than you might think.

Our number one tip is to try to keep it simple – simple is clean, elegant, and visually pleasing. For hard-line bending, make those 45s and 90s tight; not 85, not 95, you want 90. Any more or any less, and the end result is a "well almost" scenario, and you don't want that. Also, aim to have at least an inch or two coming off a bend into a fitting – it makes the whole dynamic of the loop more interesting and not seem cut short. Bleeding a loop can be a long process, so be prepared to tip and angle the case to get the air moving around the loop. Microbubbles will persist and eventually work their way out; just keep an eye on things and top up as required.

Finding inspiration

Planning a new build is an exciting time. You know the sort of look you want, but can't nail it down. Well, whatever case and part combination you have, chances are there is already a system out there with a full custom loop installed. Search the web, find inspiration from a previously completed build, a theme, colour combination, sports team, your favorite game. Take pictures of certain aspects you want to incorporate from other builds you have seen, sketch ideas, play with fun reservoir placements – it all leads to something new and different.

Maybe take it one step further: Paint the case, etch the glass, add custom cables, a sleeper build, a desk build, the possibilities are only limited by your own creativity. Make the build your own, make it stand out from the crowd, and enjoy it – not just using it, but the journey of building it, too.

Servicing – before and after

Every new system needs the components flushed before use, especially radiators, due to debris left over from the manufacturing process, which can clog up a whole loop, leading to problems down the line. Pressure testing before filling the loop is also a wise idea; unless you are super-confident, but we wouldn't advise skipping this either, because a leaky system won't last long.

Coolant choice is subjective; however, make sure you pick something that is designed for long-term use. There are some great colour options, but beware that some are designed for only short-term use, such as exhibitions – these need flushing to remove all sediment from a system, and may stain reservoirs and blocks, too. Finally, stick a slot in your diary a year from now; an annual system flush, coolant change, and dust-off is essential for maintaining a healthy, happy system.

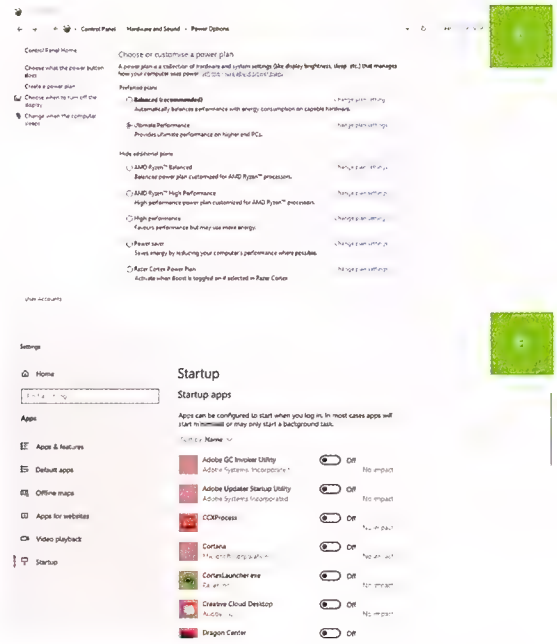
Amp up your frame rate

Get your game going. Sam Lewis

Everybody and their dog wants to get the most out of their PC. Speed is key, and it's a waste if you've got a rig that isn't giving you all it can. There's always overclocking, but if you don't want to disappear down that rabbit hole just yet, we have a few things you can do to your build that should help get things running a little more smoothly. If nothing else, you will get a little peace of mind knowing you have tried these tips, but hopefully you will see increased performance and be able to crank up some game settings. Every little counts here, especially when it comes to competitive gaming.

Enable ultimate performance

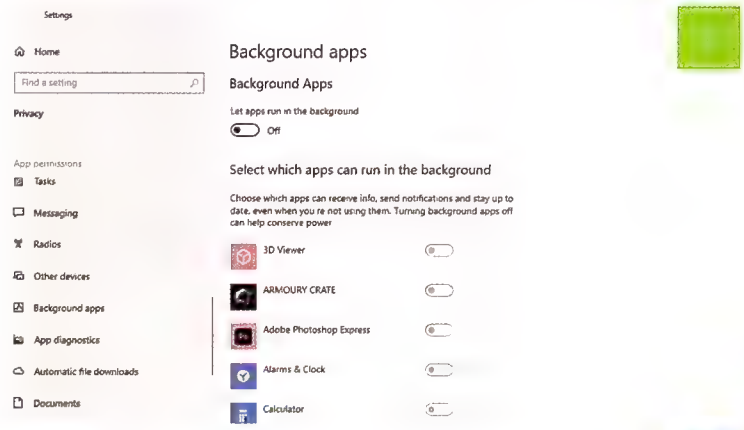
One of the first things you can do to help speed up your PC or laptop's performance is to check what power plan you are running. Head to "Control Panel > Hardware and Sound > Power Options." This should show a list of preset power plans. To see all available options, click the drop-down arrow labeled "Show additional plans," and make sure you are running your PC on the "Ultimate performance" option [Image A]. If using a laptop, ensure you are plugged in when using this setting, otherwise your battery life will be no better than that of an iPhone 4. Yikes. Switch back over to "Balanced" when unplugged to preserve your battery life.



Disable startup apps

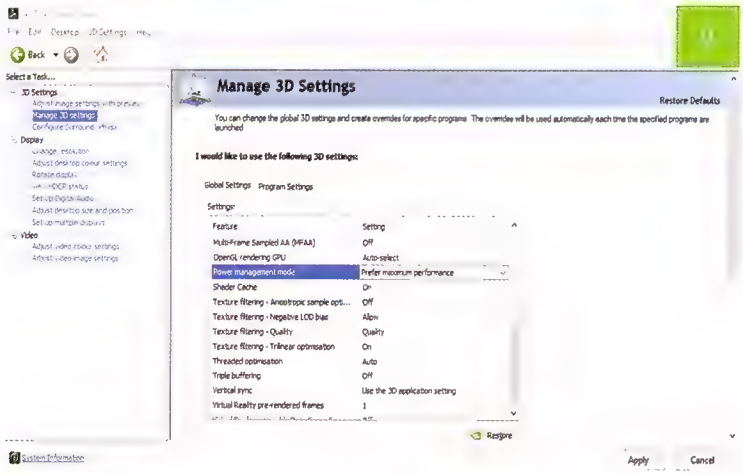
Sure, startup apps can be beneficial when you boot up your PC in the morning – you don't have to mess around opening them all up, and it allows you time to get a cup of hot joe. However, if you head into your settings and search for "startup," you will probably notice that there are a whole lot of apps there that you don't use on a regular basis, which are opening up, making your taskbar an eyesore, and hogging precious CPU cycles. You don't want these clogging up your PC, so turn off what you don't need [Image B] – it will help keep your PC tidy, too.

YOU'LL NEED THIS
Razer Cortex
Download for free from **www.razer.com**.



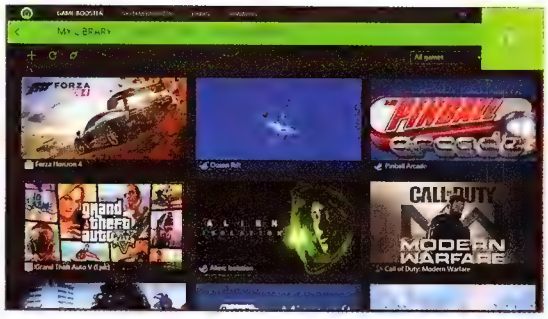
Disable background apps

Similar to the previous step, there are often things running behind the scenes that you don't know about, even if you haven't technically opened the application. Apps running in the background are useful, especially if they provide you with important information and notifications, but with enough of them lurking in the shadows, they can hinder your PC's performance. Head to your PC's settings, then go into the "Privacy" section and find the "Background apps" list [Image C]. You can manually toggle specific apps on or off, but if you want, you can give background apps the big middle finger, and hit the kill switch to put a stop to all of them.



NVIDIA 3D settings

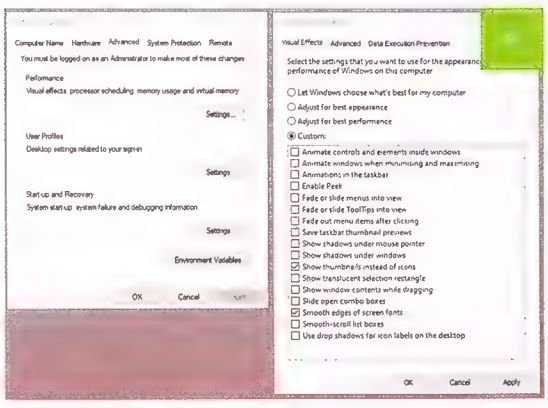
Instead of heading into the Windows Control Panel, we need



to dive into Nvidia's control panel (if you're running an Nvidia GPU). You will see a panel on the left with three options: "3D Settings," "Display," and "Video." Under "3D Settings," go into "Manage 3D Settings," and you will see a long list of options. The ones we need to change are "Power management mode" and "Texture filtering quality" [Image D]. Change "Power management mode" to "Prefer maximum performance," and change "Texture filtering quality" to "High performance." You may worry that you might get a slightly fuzzier image, but there's no noticeable difference. If you can see a difference, simply change it back. All these tips are reversible, so see if they work for you, and if they do, stick with them to get more juice.

Razer Cortex

When trying to increase PC performance, doing it without having to spend money is always a good thing, so being able to download free software to amp up your gaming is great. Razer Cortex (**www.razer.com**) is a very simple game launcher that does all the hard work for you. The app manages and stops non-essential processes and apps to produce a smoother gaming experience. It features a library that organises all of your titles, a settings booster, a PC cleaner, and information about your setup. To help with games, you need to go into the "Boost" section in the green window [Image E], and select "Auto-boost." This automatically runs a system boost whenever launching a game – pretty handy, especially for free.



Access Advanced system settings to tweak various performance settings.

System properties

Once again, you need to start in the settings, so in the search bar type "about PC." On the "About" page, scroll down to the bottom and click the option that says "Advanced system settings." This opens up a new window. In the "Performance" section, click the "Settings" button. Again, this opens another window, where you can toggle various visual performance settings on or off [Image F].

We all like visual effects, but if you can sacrifice some fancy shadows and animations for better performance, which path are you taking? For us, we chose the "Custom" option, and kept "Smooth edges of screen fonts" selected, and also "Show thumbnails instead of icons." What you choose is up to you – if you want to have specific visual effects left on, keep them, but the fewer you have checked, the better performance you will have.

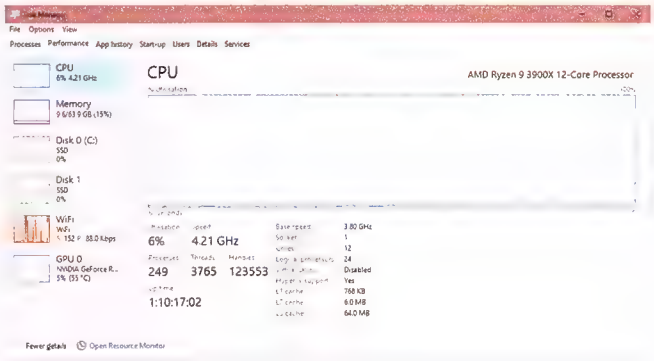
Task Manager

The Task Manager is an advanced tool built into Windows 10. This handy piece of software provides lots of information about how your PC is running and behaving. Details found in the app may be able to help you find the cause of an issue you are experiencing. It monitors the software, processes, and services running on your computer, displaying the data in real-time graphs.

At the top of the window, you can see a "Processes" tab. If it feels as though something is dragging the performance of your PC down, this should be one of the first places to look. The "Processes" tab shows you which applications are running and which pieces of hardware are being affected. To see which components are being impacted the most, click on "Processes," and it shows you how much of your resources each application is using. This shows at a glance whether a particular application or game is taking its toll on your CPU, GPU, and so on, and how much of their resources the app or game is using.

In the "Performance" tab, you can see a lot of technical information about your PC, including your CPU, memory, disk information, Wi-Fi data, and GPU. This is very handy for seeing if your speeds are up to scratch. You can look at your CPU's speed, for example, with a live data chart of how it's performing. In a way, you can think of the chart like a car on a dyno. If the car is pushed harder and increases its performance, the bar graph spikes, displays all the speeds, and shows you how linear the growth is. It's exactly the same for your PC's speed.

So, if you have a problem, before panicking, check out the Task Manager, look at how your PC is running, go to the "Processes" tab, and find the culprit. From there you can decide what to do – whether to re-install that application, update it, or uninstall it to help the performance of your PC.



Improve video calls in Nvidia Broadcast

Put that card to practical use, with Ian Evenden.

That expensive GPU humming away in your rig isn't just for games or Folding@home work units – at least, not if it comes from Team Green. Nvidia Broadcast can also improve your calls and meetings by processing the audio and video streams to remove noise and echoes, or replace backgrounds, blur them, and even automatically crop the video to frame you more prominently.

The app used to be called RTX Voice, and if you're still using a GTX GPU, you can get hold of the old app, which will run happily on your card but doesn't do the camera stuff. Broadcast is RTX-only, however, so you need an RTX2060 or bigger/newer. According to the site, you also need 8GB of RAM and an i5-8600/R5 2600 or better. So, without further ado, let's look at how you can improve your calls with your graphics card.

Install Broadcast

Simple enough, this step. Go to **www.nvidia.com/en-us/geforce/broadcasting/broadcast-app**, download the file and install the app.

Adjust audio

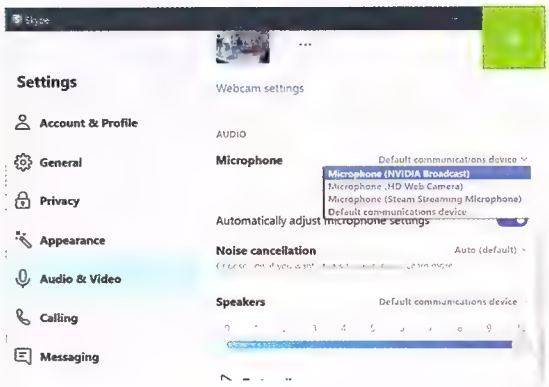
Make sure you've got your PC's microphone attached and working – you can delve into the settings to test it, or most voice apps allow you to make a test call, or at least see flickering level indicators that show your voice is being received. With Nvidia Broadcast running, you'll see it appear as a new input in the camera and microphone sections of your meeting app's settings. We've used Skype as an example [Image A]. Set it as your input, then return to Broadcast to fiddle with more settings.

Microphone musings

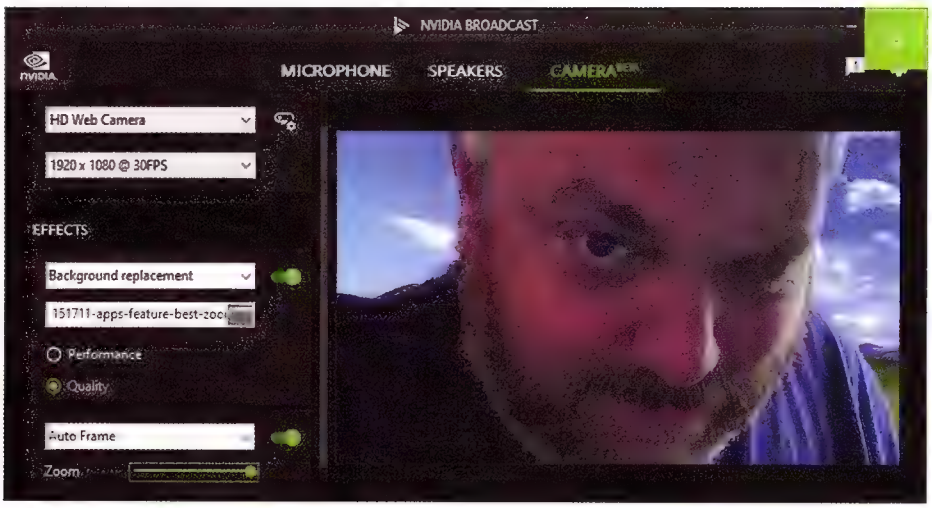
The latest update to Nvidia Broadcast enables it to recognize and remove pet sounds from your audio. No, not the Beach Boys album, but any noise dogs and cats might make that interrupts you. It can remove the clicking of a keyboard, too, and the sound of cicadas. They don't make good pets, though. In the app's "Microphone" section, choose "Noise removal" from the drop-down menu under "Effects," and slide the switch to the right to activate it. Then click "Add Effect" to stack the other effect, which removes echo caused by the room you're in. There are sample audio tracks you can play to see the effect, but the best way to test them is to try them in a live call.

Speaker silence

The same effects can be applied to incoming audio in "Speakers." It works the same way, so if the sound of someone's dog is echoing off the walls of their apartment, you can silence their misery here.



YOU'LL NEED THIS
Any GeForce RTX GPU
With 8GB of DDR4, plus a Core i5-8600 or Ryzen 5 2600.



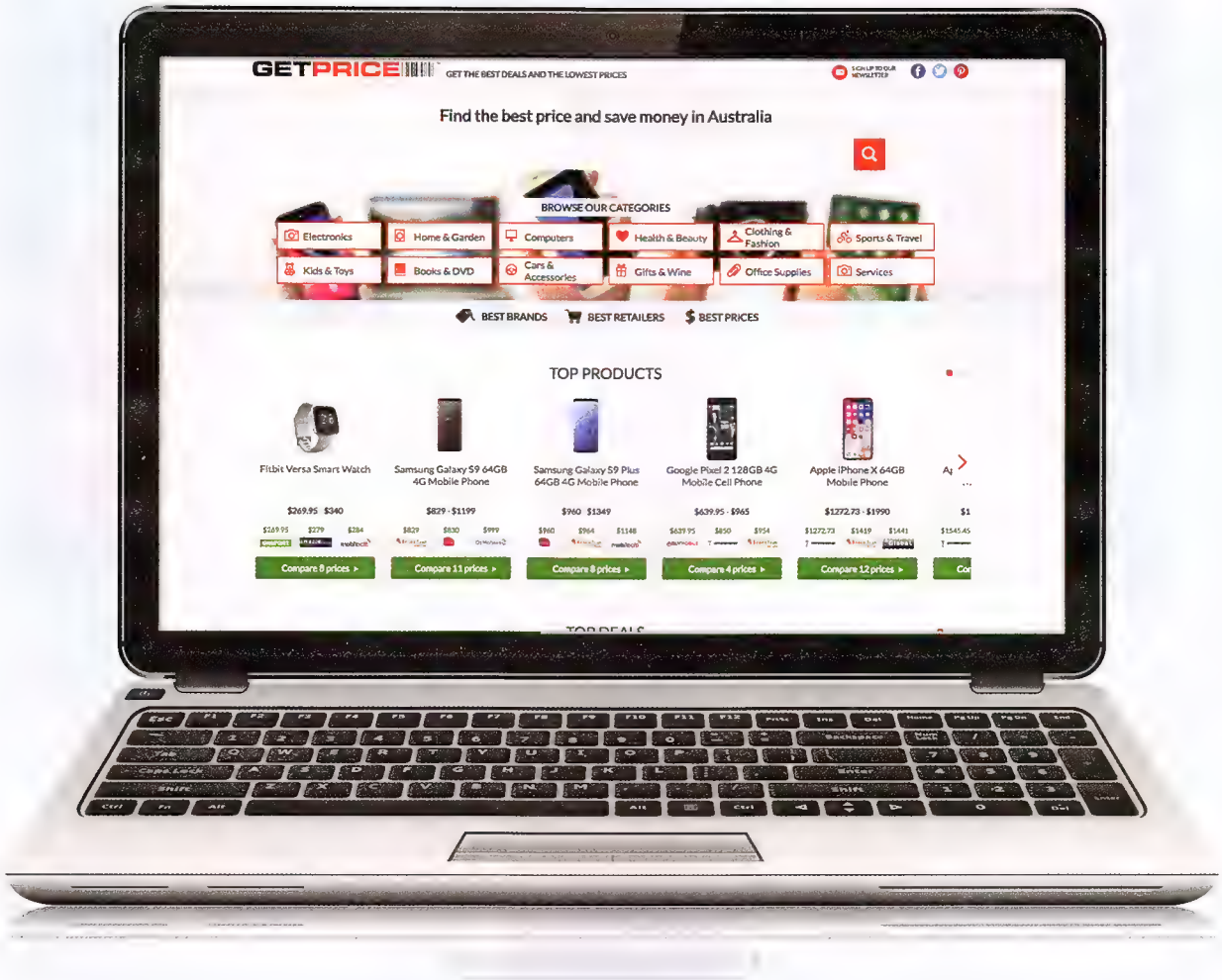
Camera tricks

It says it's beta, but the camera effects work well. We think background replacement might be a bit better than that available in meeting apps, too – but this can be difficult to measure, dependent as it is on the colour of your hair, that of your background, and how much you wiggle around during a call. You can choose two effects from a selection of five. You can blur the background, replace it, remove it (leaving you floating in a black void), or remove video noise – useful if your lighting is insufficient. There's also Auto-Frame, which zooms the image in and follows you as you move, changing the area of the camera's sensor that's used rather than moving it. There's a slider to control the zoom, so it won't go too far and just show your nose [Image B]. The latest update lets you move a bit before Auto-Frame changes the framing.

Background replacement requires an image or a movie file, but sadly not an animated GIF. Background blur has a "Strength" slider, and lets you choose between "Quality" and "Performance" modes.

Tweak settings

Clicking the cogwheel button opens a camera properties window from where you can tweak things such as the brightness and saturation of the feed. There's an "auto" option for each, but some are grayed out – it depends on the capabilities of your webcam.



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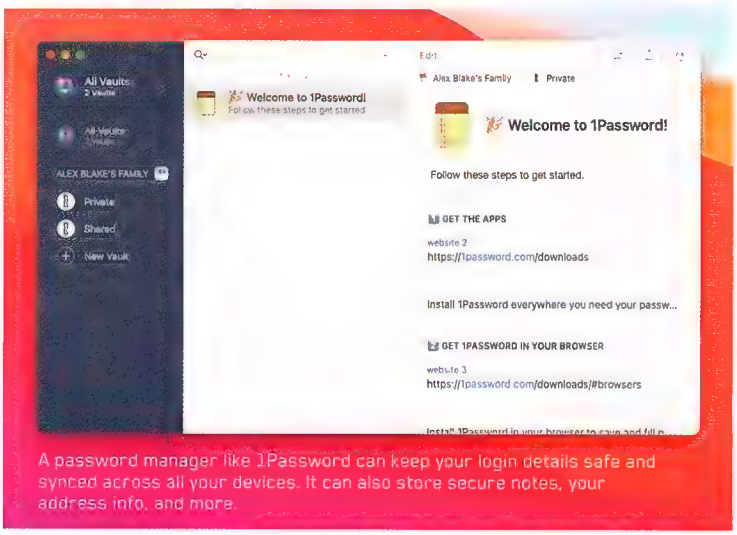
MAC

Surf safer in Safari

Keep things private and secure in Safari on your Mac.

IT WILL TAKE
10 minutes
YOU WILL LEARN
How to take control of your data when you surf the web
YOU'LL NEED
Safari, macOS 11

Apple has long tried to take an active approach when it comes to privacy, but that has ramped up noticeably in the last few years. Safari is a notable example of this. In macOS Big Sur, Apple introduced several new settings in the web browser that give you much more control over how you can stop bad actors making off with your private data. For instance, each website now gets a Privacy Report that notes how many advertising trackers Safari has blocked. There is no need to turn it on – it all works behind the scenes to keep your data safe.



A password manager like 1Password can keep your login details safe and synced across all your devices. It can also store secure notes, your address info, and more.

GENIUS TIP!
On a new tab, click the Options button in the bottom right, then tick Privacy Report. This puts a report on new tabs showing what has been blocked.

Speak to the manager

There are plenty of other actions you can take to step up your Safari security. Apart from tweaking the browser's settings – which we will cover in this tutorial – we highly recommend you download a password manager and add it to Safari. While Safari itself can remember your passwords, it is pretty basic and is of no use if you use a different browser on another device. Use a password manager like 1Password or LastPass and not only do you get more features, but you can also access all your logins no matter which browser or device you use (provided the manager is installed on each device, of course).

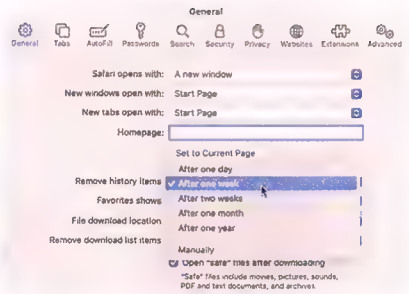
With a sturdy password manager installed and Safari optimised using the settings on the next page, your private information will be safer than ever, leaving you able to browse the web with peace of mind.

ALEX BLAKE

HOW TO Toughen up Safari's security

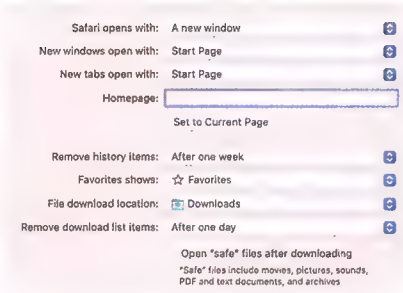
01 PRIVACY EXTENSIONS

Click Safari > Safari Extensions to open the extensions page of the App Store. Install the DuckDuckGo Privacy Essentials and Ghostery Lite extensions; these will block unwanted trackers and content from the websites you visit using Safari.



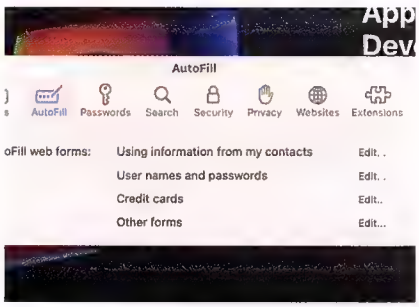
02 CLEAR YOUR HISTORY

Open Safari's preferences and click the General tab. Under the 'Remove history items' and 'Remove download list items', choose a duration. Shorter times will see your history removed sooner to protect your privacy.


Safari opens with: A new window
New windows open with: Start Page
New tabs open with: Start Page
Homepage:
Set to Current Page
Remove history items: After one week
Favorites shows: Favorites
File download location: Downloads
Remove download list items: After one day
Open "safe" files after downloading
"Safe" files include movies, pictures, sounds, PDF and text documents, and archives

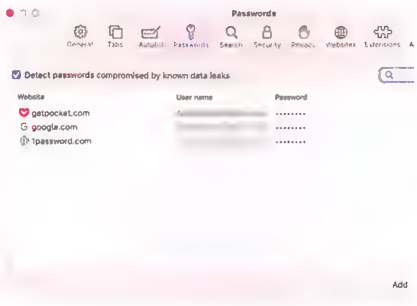
03 OPEN 'SAFE' FILES

On the same General tab, untick the checkbox next to 'Open "safe" files after downloading'. Some seemingly innocuous files can be infected with malware, so automatically opening them could cause problems on your Mac.



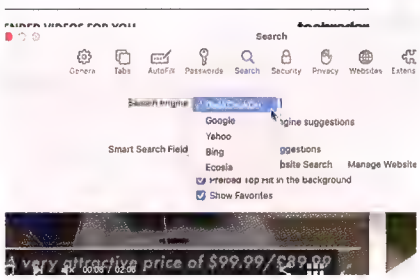
04 TURN OFF AUTOFILL

Now click the AutoFill tab. Next to 'AutoFill web forms', untick all options. If someone else uses your Mac, this will prevent things like your credit card information from being automatically entered on shopping websites.



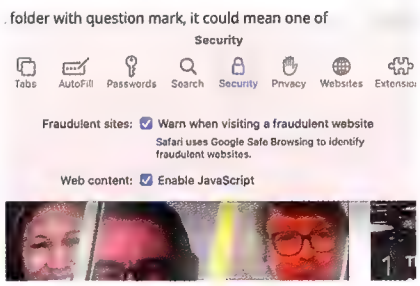
05 PROBLEM PASSWORDS

Click the Passwords tab and enter your login password. At the top of the window, ensure the 'Detect passwords compromised by known data leaks' checkbox is ticked to get warned about passwords you need to change.



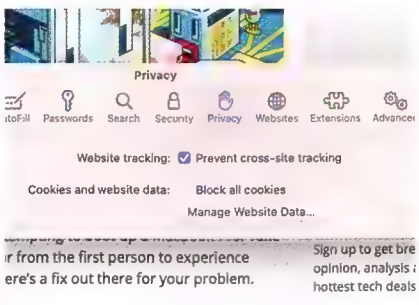
06 USE DUCKDUCKGO

On the Search tab, click the search engine drop-down menu and choose DuckDuckGo. This is a privacy-focused search engine that does not collect or store anywhere near as much of your data as Google, Yahoo and Bing do.



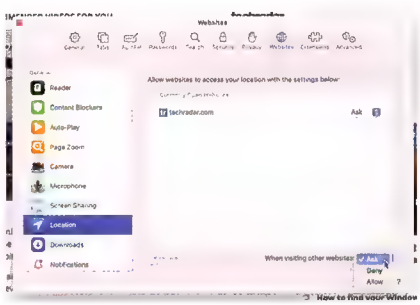
07 DETECT FRAUDULENT SITES

Move on to the Security tab and tick the checkbox next to 'Fraudulent sites' so that it is enabled. This will warn you if you visit a fake website, such as one that impersonates your bank to steal your account info.



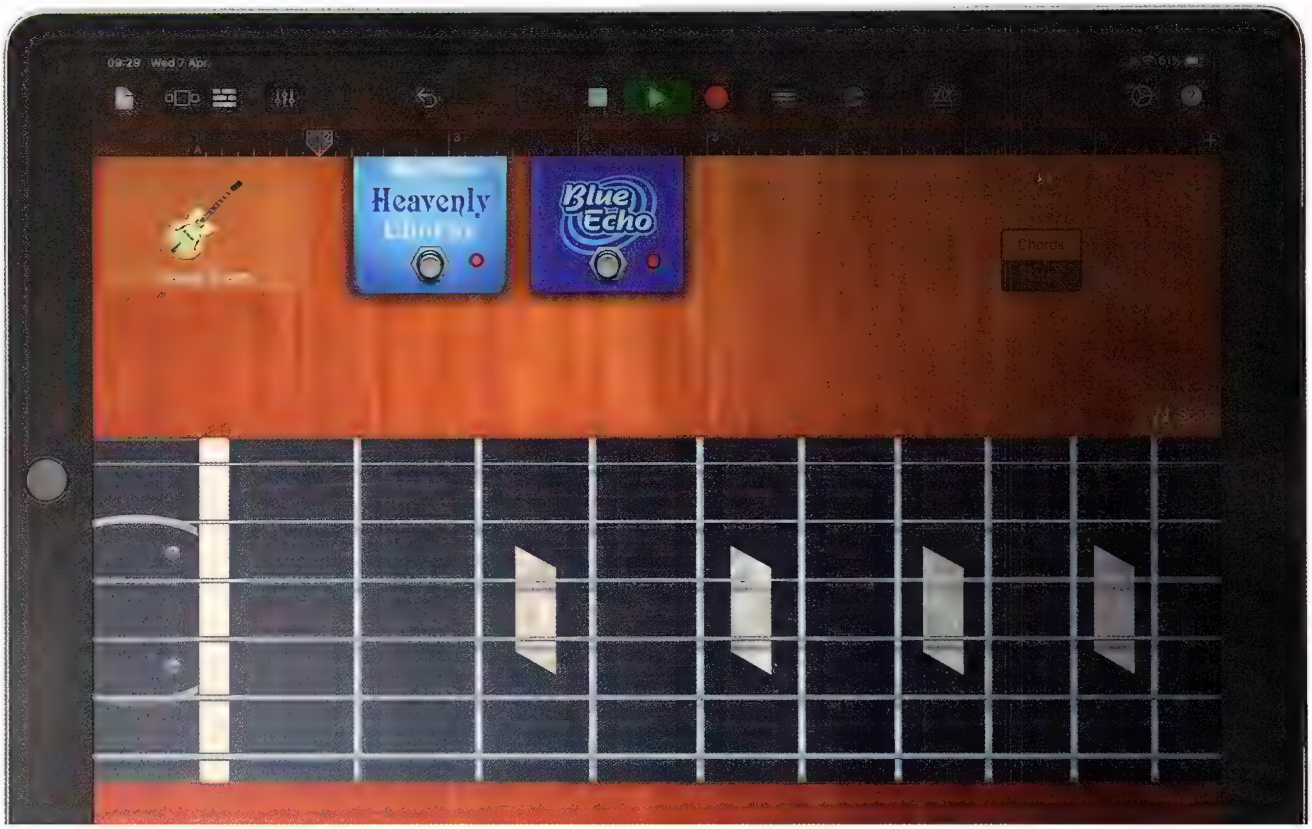
08 CROSS-SITE TRACKING

Click the Privacy tab and tick the box next to 'Prevent cross-site tracking'. If you have ever had an advert follow you across multiple websites, cross-site tracking is the reason. This feature will stop it in its tracks.



09 WEBSITE PERMISSIONS

Finally, click the Websites tab. Go through the left-hand categories to see if you want websites to access to your location data, camera, and other Mac features. You can allow all, block all, or make websites ask each time.



iOS

Make music in iOS

Make amazing tunes on iOS – even if you can't play an instrument.

IT WILL TAKE
20 minutes

YOU WILL LEARN
You will learn how to make music on iPhone or iPad

YOU'LL NEED
GarageBand. iOS 14 or later

We love GarageBand on our iPad and iPhone: it's tons of fun, easy to use, and it works brilliantly with GarageBand and Logic Pro X on the Mac. That means it's as happy in a serious music production workflow as it is being poked and prodded by a young kid on the sofa.

We use it to demo songs or capture musical ideas before turning them into finished songs in Logic; but it's as easy for complete novices to experiment with unusual instruments and make block-rocking beats.

There are lots of great music apps for iOS and iPadOS, with faithful reproductions of vintage synths rubbing shoulders with all kinds of beat makers and loopers. You can use many of them to record into GarageBand: look for Inter-App Audio apps in the App Store. Once installed, you can then use that app by choosing External in GarageBand's sound browser and picking the app you want to get audio from.

CARRIE MARSHALL

HOW TO Make music on your iPhone or iPad

01 PICK WHAT TO PLAY

Launch GarageBand and create a new song. Let's pick an instrument from this, the Sound Browser. Swipe left or right for different instrument types and tap the icons to select a specific one such as Alchemy Synth.

02 MAKE SOME NOISE

We picked this synth because you can play it with one finger: select Fast Gate from the middle section and hold down a piano key to hear a bubbling synth pattern. To record it, press the red circle icon before pressing the key(s).

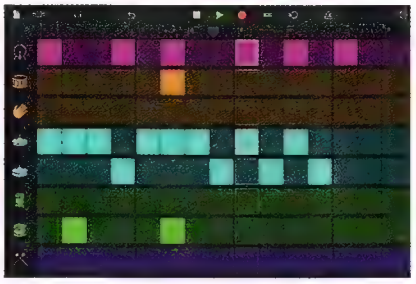
03 SEE YOUR STUFF

Tap on the third icon from the very top left to enter Tracks view. The green block is what you just recorded. Drag the ends to trim it, double-tap and select Loop. This repeats the recording to fill the entire song section.

"There are lots of great music apps for iOS and iPadOS, with faithful reproductions of vintage synths rubbing shoulders with all kinds of beat makers and loopers. You can use many of them to record into GarageBand."

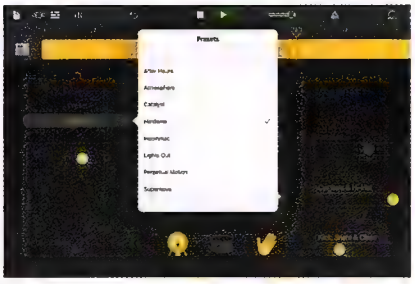
04 DO SOME DRUMMING

Let's add some drums. Tap on the '+' sign at the bottom left to add a new track and swipe until you see Drummer. This enables you to use GarageBand's automated drum machine, which can sound exactly like real-life drumming.



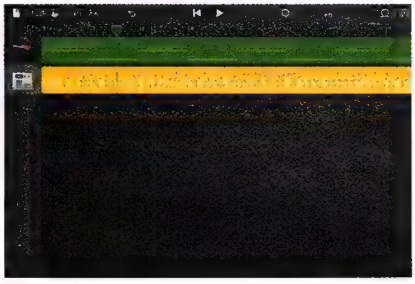
05 BUILD SOME BEATS

If you'd rather make beats, swipe along to Drums and tap Beat Sequencer. This enables you to build beats by tapping where you want each part of the drum kit to play. Tap at the bottom-left corner for a different drum kit.



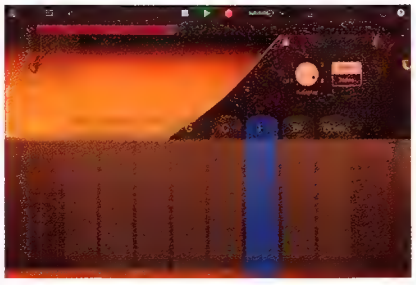
06 ADJUST THE DRUMS

We'll stick with Drummer. You can adjust lots of things from here: the drum pattern preset, the patterns for each bit of the kit and our favourite bit, the controller that enables you to make the drums louder or more complex.



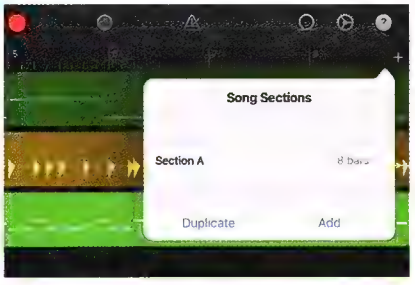
07 SEE THE DRUMS

Go back into Tracks view (the third icon from the top left) and you'll now see two tracks: your original looped synth part, and your new Drummer track. Double-tap either one and choose Edit if you want to change the notes or pattern.



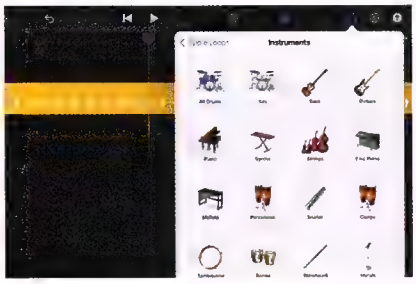
08 BRING THE BASS

Add a new track, choose bass and look for the Autoplay control: it can play the instrument for you, and there are four patterns. If you prefer you can play each individual note by tapping Notes. Use either option and record a bass line.



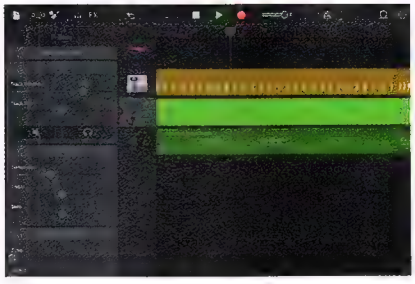
09 ADD A CHORUS

Return to tracks view, which now has three individual tracks. Let's add another song section to our project, such as a chorus. To do that, tap on the '+' sign at the top right, just above your first track. Now tap on Add.



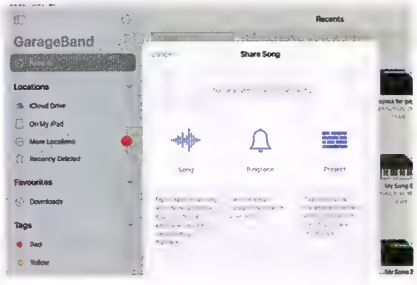
10 LOOK FOR LOOPS

GarageBand creates a new section and, if you're using Drummer, automatically puts a new Drummer section in it. Now let's add some loops from GarageBand's excellent library. Tap the Loop icon towards the top right.



11 ADJUST AND ADD FX

Find a loop you like and drag it below your tracks to add a new one. Select any track and tap the Mixer icon at the top left to adjust how it sounds, add echo and reverb and adjust where it sits in relation to the other tracks.



12 SHARE YOUR SONG

Tap the page icon (top left) and GarageBand will save your song. You can export your project by long-pressing it and choosing Share. You can export it as an audio file, ringtone or project to send to another GarageBand user.

Vet your USB devices

Security is more than just a strong password. Shashank Sharma is always on the hunt for robust techniques to safeguard his data.

A security breach can come not only from the internet, but also USB devices. Furthermore, USB devices can also be used to remove your data. If you want to protect your machines from unknown USB devices, USBGuard is just the tool for you.

You'll find the utility in the software repositories of popular distributions such as Ubuntu and Fedora, and can even install it on Arch, where USBGuard is available in the AUR. It only has a few small dependencies such as **libsodium**, which is a software library for encryption, decryption, signatures and password hashing. You'll find a list of all the dependencies on the project's website, along with instructions on compiling USBGuard from source, if it isn't packaged for your distribution.

Secured USB access

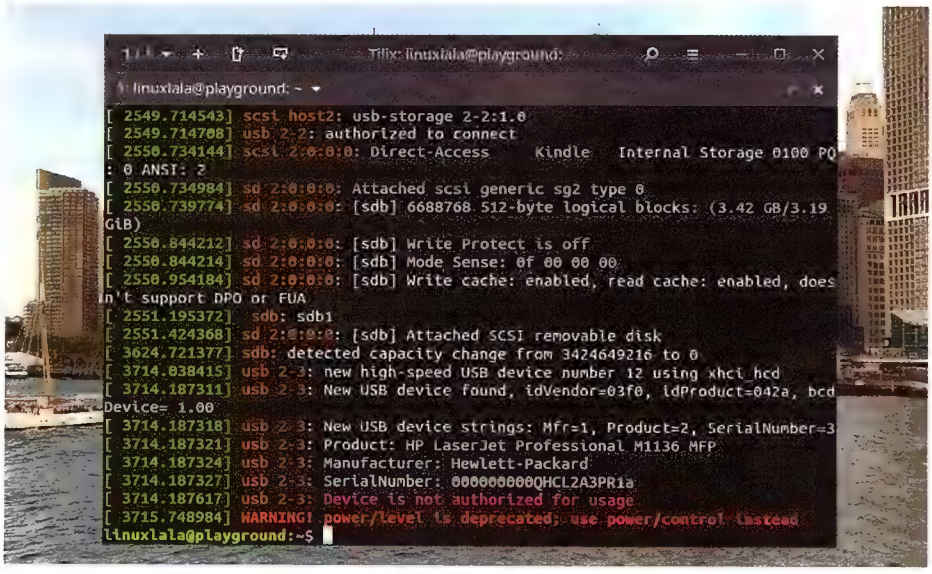
USBGuard enables users to create rules to allow or block USB devices. This can be pen drives, and other devices that you can connect over USB such as your Kindle or printer. Depending on how you install the utility, you'll either find a default configuration in the **/etc/usbguard/rules.conf** file, or you'll have to manually create the rules file. USBGuard can be configured to allow all USB devices connected to the machine. So if you use a USB printer, or other devices that are connected to your machine, the default rules will enable you to continue working with such devices.

Once you create the rules file, all new USB devices will be blocked. Which means you won't be able to use these devices until you explicitly allow them.

If you're running Ubuntu or derivative distribution, `sudo apt install usbguard` will install USBGuard. Use `sudo dnf install usbguard` to install it on Fedora. Alternatively, download the source tarball and follow the installation instructions after installing all the dependencies. Once installed, you should check if any default rules have been written in the **/etc/usbguard/rules.conf** file. If not, you'll have to create the rules file before you can begin using USBGuard. Run `usbguard generate-policy > rules.conf` to create the rules file. You can choose to store the rules file in any location, including the current working directory. USBGuard expects the rules.conf file to be stored in the **/etc/usbguard/** directory, so we must move the file there, while ensuring the necessary write permissions and ownership information:

```
$ sudo install -m 0600 -o root -g root ~/.usbguard/rules.conf /etc/usbguard/rules.conf
```

QUICK TIP
Any time you modify the /etc/usbguard/rules.conf file, you must restart the USBGuard service with the sudo systemctl restart usbguard.service command.


Tilix: linuxlala@playground:
linuxlala@playground: ~
[2549.714543] scsi host2: usb-storage 2-2:1.0
[2549.714708] usb 2-2: authorized to connect
[2550.734144] scsi 2:0:0:0: Direct-Access Kindle Internal Storage 0100 PQ
: 0 ANSI: 2
[2550.734984] sd 2:0:0:0: Attached scsi generic sg2 type 0
[2550.739774] sd 2:0:0:0: [sdb] 6688768 512-byte logical blocks: (3.42 GB/3.19
GiB)
[2550.844212] sd 2:0:0:0: [sdb] Write Protect is off
[2550.844214] sd 2:0:0:0: [sdb] Mode Sense: 0f 00 00 00
[2550.954184] sd 2:0:0:0: [sdb] Write cache: enabled, read cache: enabled, does
n't support DPO or FUA
[2551.195372] sdb: sdb1
[2551.424368] sd 2:0:0:0: [sdb] Attached SCSI removable disk
[3624.721377] sdb: detected capacity change from 3424649216 to 0
[3714.038415] usb 2-3: new high-speed USB device number 12 using xhci_hcd
[3714.187311] usb 2-3: New USB device found, idVendor=03f0, idProduct=042a, bcd
Device= 1.00
[3714.187318] usb 2-3: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[3714.187321] usb 2-3: Product: HP LaserJet Professional M1136 MFP
[3714.187324] usb 2-3: Manufacturer: Hewlett-Packard
[3714.187327] usb 2-3: SerialNumber: 000000000QHCL2A3PR1a
[3714.187617] usb 2-3: Device is not authorized for usage
[3715.748984] WARNING! power/level is deprecated; use power/control instead
linuxlala@playground:~$

Newly connected devices will show up in the output of the dmesg command, but will remain unusable until authorised by USBGuard.

The install command can be used to copy files to the specified location, and also define the attributes such as permissions and ownership. In this case, we've copied the manually created **rules.conf** file stored in the **~/.usbguard** directory and written into the **/etc/usbguard/** directory but also changed its permissions to 600, and specified the root user as the file's owner.

With a rules file in place, enable USBGuard by running `sudo systemctl start usbguard.service` . From this point onwards, all USB devices connected to your machine will continue to work, even after you reboot, without any user intervention. But when you plug in a new USB device, no matter the type, it won't be available for use.

This is the output when we connect a Kindle to our USBGuard protected machine:

```
$ dmesg
[ 418.705142] usb 2-2: New USB device strings: Mfr=1, Product=2, SerialNumber=3
[ 418.705148] usb 2-2: Product: Amazon Kindle
[ 418.705151] usb 2-2: Manufacturer: Amazon
[ 418.705154] usb 2-2: SerialNumber: 9017220251460AUC
[ 418.705411] usb 2-2: Device is not authorized for usage
$
```

The device is identified, but the last line reveals that the 'Device is not authorised for usage',. This is because we've not allowed the device in our USBGuard rules.

Allow a device for use

For a list of all USB devices recognised by USBGuard, you must run `usbguard list-devices` :

```
$ usbguard list-devices
19: allow id 5986:055a serial "200901010001" name "Integrated Camera" hash "ETI2CKmIMbDfaQbPTk/q3l7qh/vXK3MVN3zFzF+yGfo=" parent-hash "jEP/6WzviqdJ5VSeTUY8PatCNBKeaREvo2OqdpINDJo=" via-port "2-8" with-interface { 0e:01:00 0e:02:00 0e:02:00 0e:02:00 0e:02:00 0e:02:00 0e:02:00 0e:02:00 } with-connect-
```

type "not used"

20: block id 1949:0004 serial "9017220251460AUC" name "Amazon Kindle" hash "EXNrjLa/uQqzfXwlqxGAJhd4DP7nBN5MBzQ5hUQ73qc=" parent-hash "jEP/6WzviqdJ5VSeTUY8PatCNBKeaREvo2OqdpIND/o=" via-port "2-2" with-interface 08:06:50 with-connect-type "hotplug"

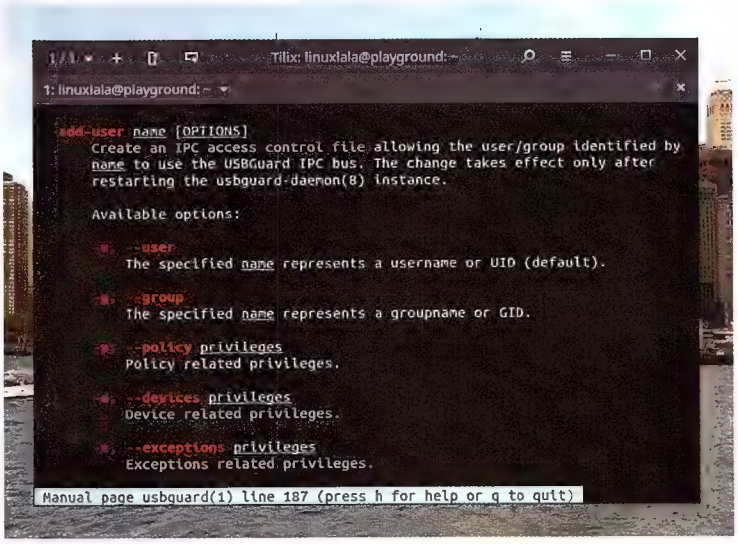
We've had to truncate the output of the usbguard list-devices command due to space constraints. But you can see from the output that each recognised device is given a number, followed by either the word "allow" or "block" and a host of information to identify the device, including the connection port. This is useful because you can configure USBGuard to allow a device, but only if it's connected to the specified USB port.

You can temporarily allow a connected device after you've identified its associated number with usbguard allow-device <number> . For instance, in our example, if we wish to allow the Kindle device, we can do so with the usbguard allow-device 20 command:

```
$ usbguard allow-device 20
$ usbguard list-devices
20: allow id 1949:0004 serial "9017220251460AUC" name "Amazon Kindle" hash "EXNrjLa/uQqzfXwlqxGAJhd4DP7nBN5MBzQ5hUQ73qc=" parent-hash "jEP/6WzviqdJ5VSeTUY8PatCNBKeaREvo2OqdpIND/o=" via-port "2-2" with-interface 08:06:50 with-connect-type "hotplug"
```

We've again truncated the output of the usbguard list-devices command, but as you can see, the Amazon Kindle, with unique ID 20, is no longer blocked.

You can also configure USBGuard such that only permitted users on the machine are authorised to use the utility to allow or block devices.


Tilix: linuxlala@playground: ~
1: linuxlala@playground: ~
add-user name [OPTIONS]
Create an IPC access control file allowing the user/group identified by name to use the USBGuard IPC bus. The change takes effect only after restarting the usbguard-daemon(8) instance.
Available options:
-u, --user
The specified name represents a username or UID (default).
-g, --group
The specified name represents a groupname or GID.
-p, --policy privileges
Policy related privileges.
-d, --devices privileges
Device related privileges.
-e, --exceptions privileges
Exceptions related privileges.
Manual page usbguard(1) line 187 (press h for help or q to quit)

But allowing a device in this manner is only a temporary solution. As soon as you unplug the device, or restart the machine, the device will show up as blocked when you connect it again. This is because we haven't written a rule allowing this device in the **/etc/usbguard/rules.conf** file.

You need a variety of information when adding a new rule to **/etc/usbguard/rules.conf** file. These include the device ID, serial number, name, hash, parent hash, via-port and other information. All this information is reported as the output of usbguard list-devices .

Once you've identified the information, you can add it to the **/etc/usbguard/rules.conf** file. For instance, to allow our Amazon Kindle to always be allowed, we must add the following to the **/etc/usbguard/rules.conf** file:

```
id 1949:0004 serial "9017220251460AUC" name "Amazon Kindle" hash "EXNrjLa/uQqzfXwlqxGAJhd4DP7nBN5MBzQ5hUQ73qc=" parent-hash "jEP/6WzviqdJ5VSeTUY8PatCNBKeaREvo2OqdpIND/o=" via-port "2-2" with-interface 08:06:50 with-connect-type "hotplug":
```

Here's the via-port information is quite important, because if we try to connect the Kindle through some other port, it won't work. You can similarly deauthorise a device by either running usbguard <block-device :number> , or by deleting the relevant rule from the **/etc/usbguard/rules.conf** file.

The USBGuard utility is useful, especially if you wish to safeguard your machine from unknown devices. Please refer to the man page, and explore the documentation, especially about creating rules so that you don't accidentally render a key device unusable.

Block all USB storage devices

The USBGuard utility should be sufficient for most users. But it's also possible to permanently disable the use of all USB storage devices.

The easiest way to do this is to use the blacklist.conf file to prevent the use of USB storage devices:

```
sudo echo "blacklist usb-storage" >> /etc/modprobe.d/blacklist.conf
```

When a USB device is plugged, the Linux kernel loads the usb-storage module. You can prevent this module from being loaded, which in effect will prevent the USB storage device from being usable:

```
$ sudo su
[sudo] password for linuxlala:
# echo 'install usb-storage /bin/true' >> /etc/modprobe.d/disable-usb-storage.conf
# exit
$
```

For a more drastic solution, you can remove the kernel modules used for USB storage devices. First, you must use the lsmod command to identify the relevant modules:

```
$ lsmod | grep usb_storage
usb_storage    73728 1 uas
```

Now, remove the usb_storage as well as the uas module:

```
$ sudo su
[sudo] password for linuxlala:
# modprobe -r usb_storage
# modprobe -r uas
# lsmod | grep usb_storage
# exit
$
```

Finally, rename the USB storage module from being loaded. Identify the current kernel by running the uname -r command. Now navigate to the **/lib/modules/<current-kernel>/kernel/drivers/usb/storage** directory and rename the **usb-storage.ko** module to **usb-storage.ko.blacklist**. Depending on your distribution, the module could be named **usb-storage.ko.xz**.

Blast the evil mutant space bats

Les Pounder has landed on a new planet and the evil mutant space bats are trying to steal his space snacks. Defend those provisions with your life!

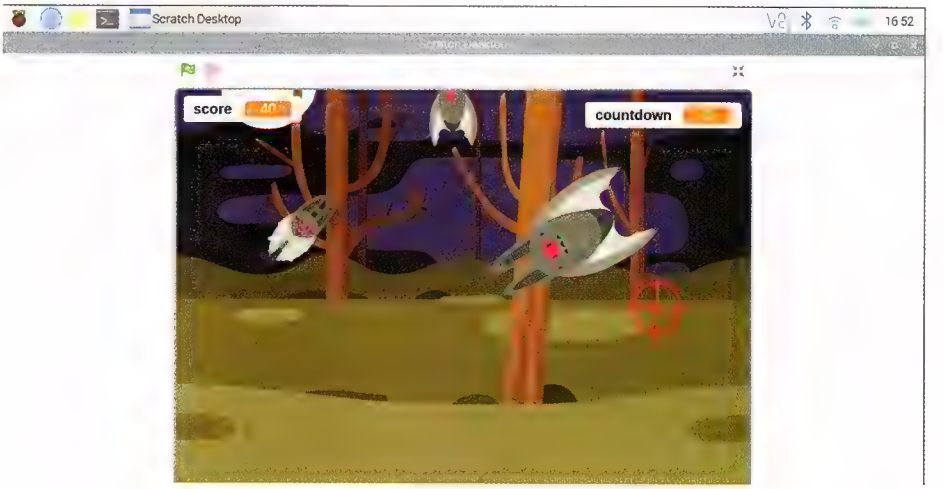
Continuing our Scratch projects, and after blasting off from the planet of the evil space aliens we've now landed on a mysterious planet with evil space bats, intent on eating our space food rations. To stop the bats from eating our food we need to SPLAT THE BATS with our space ray guns.

Scratch 3 should come pre-installed on your Raspberry Pi OS image, but just in case it's missing it can be installed from the main menu, under Preferences > Recommended Software. Scratch 3 is found in the Programming category – place a tick in the box and click Apply to install. Once installed, Scratch 3 can be found in the main menu under Programming.

Launch Scratch 3. We're going to start with a new sprite. In the bottom-right of the screen click the Cat sprite and then click the trash can icon to delete the cat. In the same section look for an icon that looks like a cat with a plus sign above it. Click this and select **Choose a sprite**. Look for the Bat sprite. This sprite has four costumes, which are used to give basic animation to the sprite. Click the bat and it'll appear in the box.

We're going to write code for the bat, so make sure it's selected. The first block of code is the trigger that starts the game. From the Events blocks, drag the **When Green Flag Clicked**. Next we go to Variables, and click **Make a Variable**. Call the variable **score** and make it available for all sprites. From Variables drag the **Set score to 0** . You may need to use the drop-down menu to select the variable.

Now go to Control and drag a **forever** loop and connect it to the previous blocks of code. The next three blocks are inside the forever loop. The first is from Looks and it's **next costume** . By changing costumes we can animate the sprite. The next block is **glide 1 secs to random position** and it's found in Motion. This block will make the bat glide around the screen.



Can you save the snacks from the evil mutant space bats? They're hungry for space food... your space food!

YOU'LL NEED
- Any Pi, best on 3/4/ 400
- The latest Raspberry Pi OS
- You can play the game at **https://scratch.mit.edu/projects/510754728**

Spinning bats

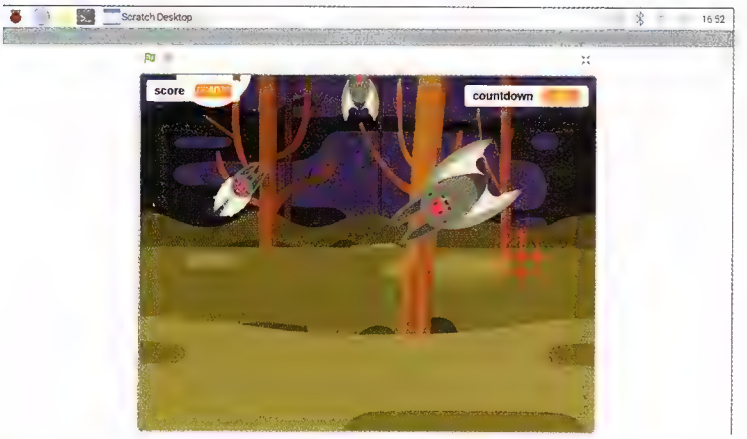
Next we add a little more animation to the bat. Grab **When Green Flag Clicked** from Events and drag it into the coding area. Go to Control, drag another **Forever** loop and connect the two. Inside the new forever loop, drag a **turn 15 degrees** block from Motion. Finally go to Control and drag **wait 1 seconds** inside the loop. Change the 1 to 0.1 to make the rotation 10 times faster.

The final section of code for this sprite starts with **when this sprite clicked** found in Events. From Sound drag **start sound** and place it under the previous block. The default sound is pop, but we want something cooler. In the top-left of the screen, look for the Sounds tab, click the tab and in the bottom-left look for the speaker icon. Click the icon and select **Choose a sound**. Go through the library and choose a sound. We used **squishy pop**. Select the sound, then click the Code tab and change the **play sound** dropdown to your chosen sound. From Variables drag **Change score by 0** and place it under the previous block, change the 0 to 1. This means if we hit the bat, we get a point.

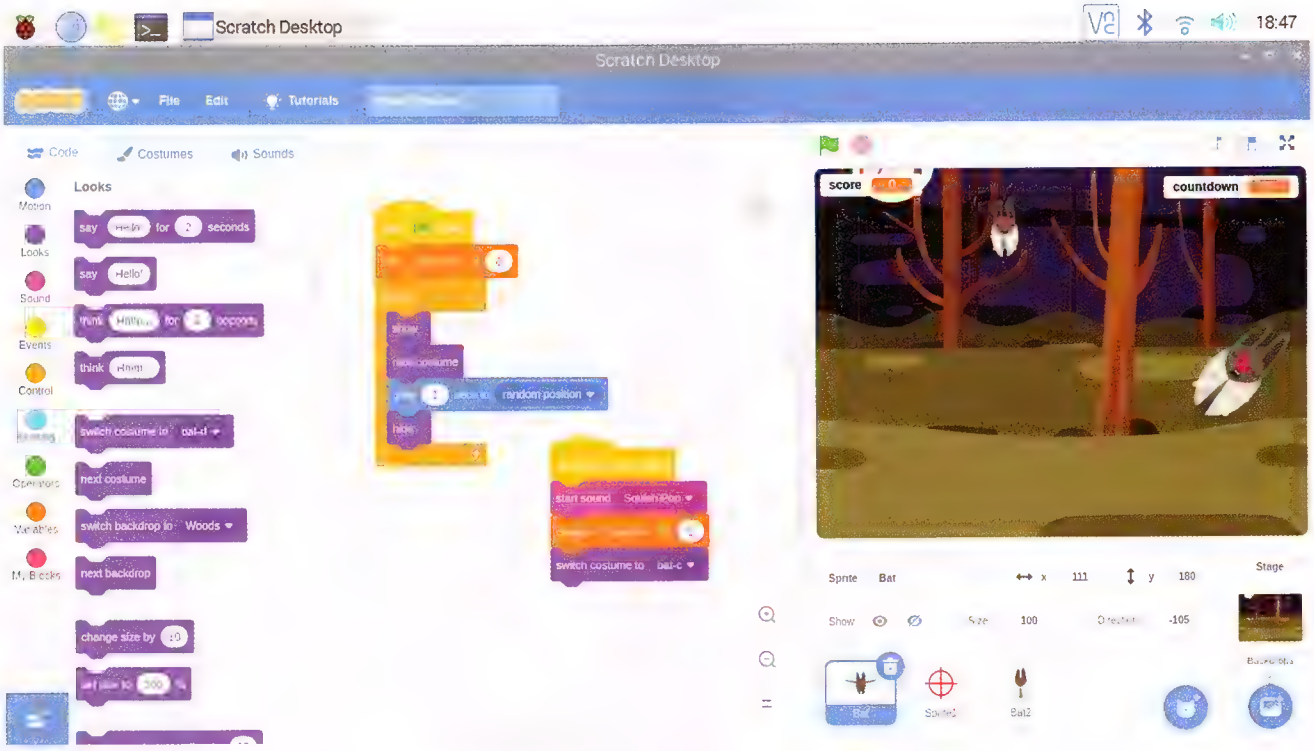
The final block is from Looks and it's **switch costume to**. Connect this to the previous block and set the dropdown to **bat-c** , which is an open winged bat that looks like it's been splatted!

Click the green flag to test the game. Does the bat move around? Does it spin? Click the bat and your score should increase by one point for every successful splat! Press the red circle to stop the game.

So we have a basic bat, but we need a super-evil mutant space bat that gives us more points, but it's



The vector editor is a great way to design your own sprites. They can also be converted to bitmaps for eight-bit games.



harder to hit. Rather than repeat the above steps, we can right-click the bat sprite in the bottom-right of the window, select **duplicate** and it appears!

We'll first edit the **When Green Flag Code** section. Underneath **set score to 0** drag a **set size to 100** block from Looks. Change the value to 50 per cent. The bat is worth more points so it should be harder to hit. Inside the forever loop we'll drag **change color effect by 25** and place it inside the loop, but above the **next costume** block. This will change the colour of the bat's nose each time the loop goes round. Remove the **glide 1 secs** block and instead add a **wait 1 seconds** block from Control. Change the value to 0.5 – this bat is quick!

Random action

The last block in this section of code is found in Motion and it's **go to random position** . This block will teleport the super mutant space bat around the screen. Next we edit the **When this sprite clicked** sequence of code. You can change the sound that plays when the bat is hit. We chose a ricochet noise to identify that we hit the super bat. Set the **change score by 1** block to 10 as the player should be rewarded for hitting this super rare bat. The final thing to do is to delete the script that rotates the mutant bat. Simply drag the blocks back to the code tab and drop them to tidy them away. Test the game – can you hit the bats? Does the scoring work?

Each sprite and the stage where our game is played have blocks of code that make up the game. By clicking a sprite or stage we can directly write code and change how it behaves.

QUICK TIP
If you need to copy a segment of code from one sprite to another, simply drag the code onto the sprite. This means we can add extra functionality without having to rewrite lots of code.

The final sections of code are for the stage, where our game takes place. Click the stage section. From events drag **When Green Flag clicked** and from Controls drag **forever**. Inside the forever loop add a **play sound ... until done** and using the Sounds tab click **Choose a sound** and look through the Loops library for sounds that will loop. Select the sound and ensure the drop-down shows the correct sound.

The final section of code starts with **When Green Flag clicked** and under that we need to create a new Variable, called **countdown**, and then drag **set countdown to 0** and place it under the block. Set the value to 30. From control drag **repeat 10** and place it under the previous. Change 10 to 30. Inside the loop drag a **change countdown by 0** from Variables. Set the value to -1. From Control drag a **wait 1 seconds** block. This loop will count down from 30 seconds to 0. When the timer reaches zero, the loop ends and the final block, **stop all** is dragged from Control to the end of the code. Click the Green flag to run the game and prepare to defend yourself!

Adding to the game

Our game world has a boring white background. We can click the Stage and in the very bottom right of the screen is an icon to choose a backdrop. Click this and browse the library to find an interesting background for the game.

How we splat the bats is also dull! We need crosshairs to ensure we splat them all! Click the Cat with a + icon and select **paint** . Here we can draw a crosshair, a circle with two lines through the centre. Make sure to draw the crosshairs near the centre of the canvas but not on the centre because it'll stop us from splatting bats! Click the Code tab and we'll add three blocks of code. From Events drag **When green flag clicked** , then from Control drag a **forever** loop. Inside the loop place **go to random position** from Motion. Change the drop down to "mouse-pointer". Now wherever our mouse cursor goes in the game, we see the crosshairs helping us to splat more bats!

Try adding more bats (duplicate the sprites) to the game, and perhaps use the **show** and **hide** blocks to have the bats magically appear in random places.

Learn to make and code with micro:bit – Part 1

Using tech is fun, but making your own tech is better. In this new three-part series, Darren Yates shows how to code the latest micro:bit v2 using only your web browser.

Micro:bit is the tiny single-board computer that teaches kids (or anyone) how to code using real hardware. It comes with features you'll find in any smartphone, including a speaker, microphone, accelerometer and Bluetooth connectivity, plus a 5x5 grid of LEDs and a number of user controls. You'll find it at most online maker retailers for under $30 and includes everything you need to get started. All you add is a Windows, macOS or Linux PC with internet access and your imagination. It's easy to use, lots of fun and all the while teaches the basics of computer science.

Hello world

To kick things off, we'll code an easy 'hello world' project to get you familiar with loading code onto the micro:bit board using your PC's web browser and file manager. The micro:bit v2 Go kit includes the micro:bit board, battery pack with two 'AAA' alkaline batteries and a microUSB cable. You won't need the battery pack to begin with, just the board and the USB cable. You can code micro:bit using a range of programming languages including Blocks, Python and JavaScript, but we'll start off with Python.

First, fire up your PC and head to **microbit.org**. Not only will you find a load of learning materials (awesome if you're a teacher), but we'll use the online editor to write and convert or 'compile' our code into a form the micro:bit board can understand. Launch **http://makecode.microbit.org** to go to the editor start page and under 'My Projects', click on the 'New Project' tile. Enter a name for your project (we used 'APC_Project_1'), then click on the 'Code Options' link below and select 'Python only'. When you're done, click the Create button.

Micro:bit editor

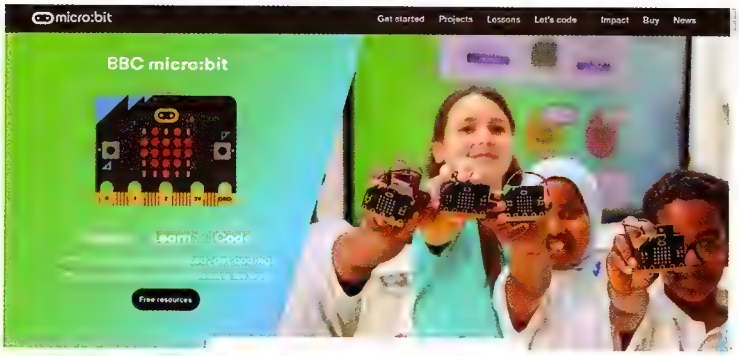
What's really nice about Microsoft's micro:bit editor is that it has a built-in micro:bit emulator – while having the real thing is always better, this means you can start coding micro:bit projects even before your kit arrives. After clicking the 'Create' button, the editor window will appear. Let's create our first Python code, so type the following, ending each line with the <enter> key:

```
from microbit import *
while True:
    basic.show_icon(IconNames.
HEART)
    pause(500)
    basic.show_icon(IconNames.
SMALL_HEART)
    pause(500)
```

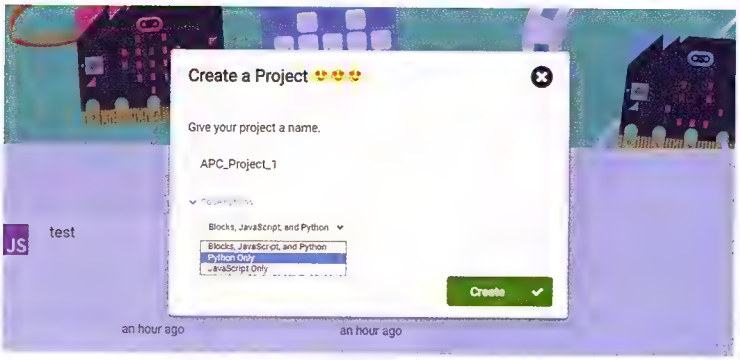
One of the most important features of the Python programming language is indentation, which tells Python when a line of code belongs to a particular segment or 'block'. The editor will automatically add the indents, but make sure you don't erase them.

The first line of code tells Python to include any code module or 'library' as necessary. The star (*) symbol is a wildcard, just like when searching for files on your computer. The second line begins a 'while' loop. A loop is a block of code (the indented code that follows) that runs from the first line of that block down to the last and repeats. A 'while' loop continues to repeat while ever the argument on the same line as the 'while' statement (called a 'condition') is true. A condition is either true or false and since the condition here is always 'true', this particular loop will run forever (or until you disconnect the power). The condition in a while loop is checked at the start of each loop run. If true, the loop runs; if not, the first line following the loop

Make sure to purchase the version 2 model.



Micro:bit is a low-cost computer you code via a PC web browser and USB.



Click the 'New Project' tile, give it a name and choose your coding language.

block is run. The code block in this loop displays a heart icon on the 5x5-LED panel, pauses for 500-milliseconds, shows a small heart icon and pauses for another half-second.

Once you type this in, you'll see a play icon appear over the micro:bit board in the left-column of the editor page. Click on it and you should see micro:bit's beating heart. Press the small square 'stop' icon directly beneath the micro:bit board icon to quit.

Plugging in your board the first time

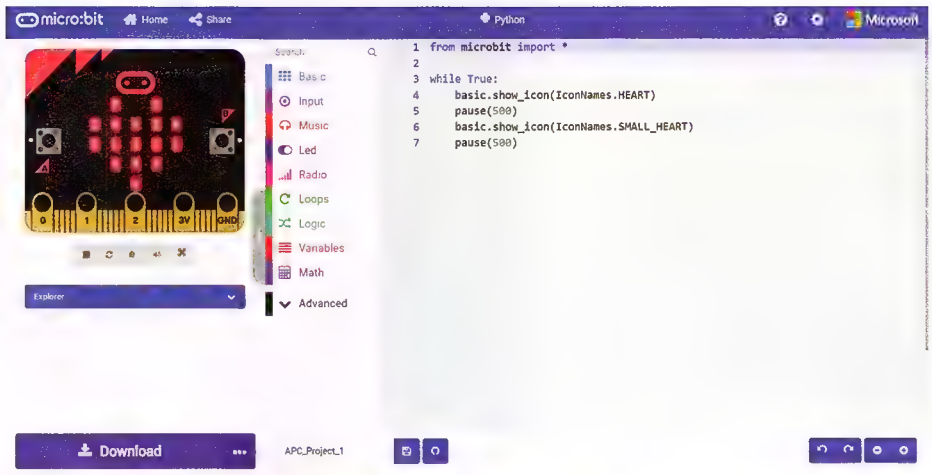
Before you code your micro:bit for the first time, the micro:bit board auto-starts a fun built-in app that gives you a brief glimpse of what it can do. Enjoy it first because your code will erase it (you can re-download it from Micro:bit at **tinyurl.com/microbitoob**).

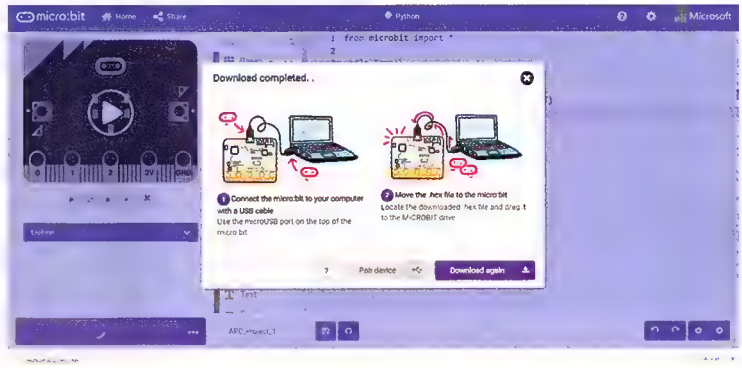
Download your code

The micro:bit board doesn't understand Python directly, so your code must be converted into a form the micro:bit chip can understands. Click on the Download button at bottom-left of the editor page and it will automatically generate the 'hex' file, then download it to your 'downloads' folder. Launch your PC's file explorer and you should see 'MICROBIT' mounted as a drive letter or option. Copy the downloaded .hex file to that 'MICROBIT' drive and the yellow LED on the back of the board will flash as it copies across. Once complete, your code runs automatically and in this example, you should see flashing heart icons on the board's 5x5 LEDs. Got this far? Congrats – you just coded and ran your first Python app on your micro:bit board.

What else?

Our second project uses the 5x5-LED panel plus the built-in microphone to create a sound level alarm. Rather than type this one in, we've published it on the micro:bit website at **https://makecode.microbit.org/_RFY9sRcXHDu0** (don't forget the underscore '_'). This time, we've coded it in JavaScript. It uses the microphone to capture sound, which is converted into a digital number. That number is then scaled so we can draw a line on the 5x5 LED panel that's proportional to the loudness or 'amplitude' of the sound captured in real-time. Once the sound level hits a pre-defined peak, it launches the micro:bit 'hello' tone or 'soundExpression' as an alarm to tell you to 'keep it down'. We've added comments all over the code to help explain how it works. Note, this code only works on a micro:bit version 2.





ABOVE: The micro:bit editor includes an emulator to test your code before uploading. **RIGHT:** Click the Download button, download the .hex file and copy it to your board.

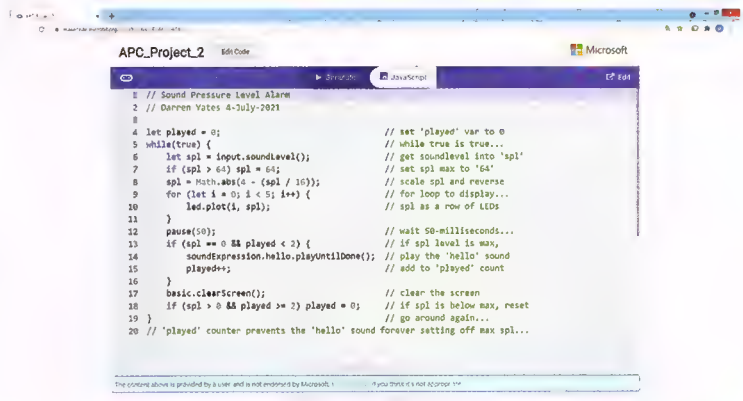
Connecting up battery power

Once you've copied or 'uploaded' the .hex code to the board, you can remove it from your PC and plug in the battery pack to use remotely. It's recommended you only use zinc or alkaline batteries for added safety. To remove the battery connector from the board, pinch the connector itself rather than pulling on the wires.

Lots to learn

Micro:bit is an excellent, low-cost way to learn basic coding, but also gives you a glimpse into how software and hardware interact. Python and JavaScript are two of the most popular programming languages to learn and power everything from machine-learning to your favourite websites, so learning either (or both) won't do you any harm.

We'll be back next month with more code and you'll find micro:bit V2 Go kits at numerous local online retailers.



We've uploaded our second project to the micro:bit website (see text).

SPECIFICATIONS CPU: Intel 80386 DX @ 16MHz **RAM:** 1MB, upgradable to 16MB, later 128MB **GRAPHICS:** 16.78 million colors @ 640x480 **SOUND:** Ricoh RF5c68 sound chip, eight-channel stereo (PCM) plus YM2612 sound chip, six-channel stereo (FM synth) **OS:** Towns OS, plus custom Japanese variants of DOS/V, Windows 3.1, and Windows 95 **STORAGE:** CD-ROM (540MB), 2x 3.5-inch floppy drives, optional hard disk or 5.25-inch floppy **JAPANESE SALES:** 500,000

MACHINE OF THE MONTH

Fujitsu FM Towns (1989)

Only in Japan. By John Knight.

Fans of obscure gaming are in for a treat this month, as we're going back to the Land of the Rising Sun to explore a different take on the PC, released only in Japan. If you've ever wanted to know what the PC would be like in an alternate reality, Fujitsu's FM Towns is the answer.

This "hyper media PC" provides a wealth of new experiences, ranging from desktop multimedia to brilliant arcade ports. So, join us as we explore a brief history of the FM Towns, and show you the easiest way to emulate it.

Background

The FM Towns was released as Fujitsu's response to the increasingly competitive Japanese computer scene, where machines such as the Sharp X68000 and NEC PC-8800 and PC-9800 series were dominating the Japanese market and eroding Fujitsu's sales. While NEC's PC-9800 series had solid sales as 16 or 32-bit business desktops, its hardware was ill-suited to gaming and multimedia. Sharp's X68000 was a gaming powerhouse, but still only 16-bit. Recognising a gap in the market, Fujitsu's new machine would be a 32-bit multimedia powerhouse based on the Intel x86 platform. However, unlike the PC, this would be a proprietary platform based around specific chipsets.

Launch

Shipping in February 1989, the FM Towns packed a 386 CPU, megabytes of RAM, and sound chips found in Sega consoles and arcades. Most notably, it was the first computer to ship with a CD-ROM drive as standard.

The FM Towns: The PC that isn't a PC, which should be experienced by any serious PC gamer.

YOU'LL NEED TSUGARU EMULATOR AND BIOS FILES
http://ysflight.in.coocan.jp/FM/towns/Tsugaru/e.html

While its combination of chipsets already allowed for solid gaming, adding CD storage was transformative. Games could now be much bigger, and CD audio could provide proper studio soundtracks instead of MIDI. The added space also allowed for early FMV, with the FM Towns becoming famous not just for in-game cutscenes but also desktop multimedia.

Over the years, the Towns was given numerous generational upgrades. The oldest and slowest models had a 386 SX CPU @ 16MHz, while the newest and most powerful model had a Pentium @ 120MHz.

Hard drives were fairly rare; most software ran and booted from CD, like a '90s console, and floppy disks were used to save games. The Towns used a two-button joypad as standard, although more advanced controllers were available.

Believe it or not, half the reason Soji wrote his emulator was simply to play *Wing Commander* with an analog joystick.

Software

Numerous operating systems are available for the FM Towns, most notably Towns OS, a graphical environment that feels something like a cross between Amiga Workbench and GEOS. Otherwise,

© Origin Systems

Japanese-modified versions of DOS, Windows 3.x, and Windows 95 are available for the system, and there have also been Linux and BSD distributions. Unlike the PC, operating systems for the Towns generally booted from CD.

Gaming-wise, the Towns has a mix of everything – usually with a Japanese twist. Arcade ports, small desktop games, manga adventures – there's something for everyone. Ports of famous Western DOS games were popular, often with enhanced soundtracks and extra content. Lengthy video cutscenes were common. To pick some highlights, arcade classics such as *Street Fighter II* and *Raiden* are well known (and both are solid ports), but connoisseurs should try *Asuka 120% Excellent* and *Viewpoint*. The Towns has arguably the best version of *Wing Commander*, and *Pu-Li-Ru-La* is probably the strangest game you will ever experience.

Legacy

Despite the Towns's technical sophistication, its high cost meant NEC's PC-98 retained its lead in Japan until the mid-'90s, leaving the Fujitsu in a fairly niche position. However, all these Japanese computers sank into obscurity after Windows 95 PCs took over the market worldwide.

In 1993, Fujitsu released the FM Towns Marty, a simplified console version of the FM Towns that was compatible with most games. The Marty was the world's first 32-bit console, launching a year before the Sega Saturn and Sony PlayStation. However, the Marty was unsuccessful and did not receive much support, even from its parent company.

The FM Towns was retired in 1997, having sold around 500,000 units.

Emulation

For English speakers, the only real choice of emulator is Tsugaru, by Soji Yamakawa. It's open source and supports Windows, Linux, and Mac.

You need to bear in mind that Tsugaru is still a work in progress, and doesn't support every feature of the Towns, but it's still worth a try. At the time of writing there was no full-screen mode and joysticks weren't working for the Linux version, but these issues may have been fixed by the time you read this.

To get started, head to the Tsugaru website (**http://ysflight.in.coocan.jp/FM/towns/Tsugaru/e.html**), where two links are provided: a GitHub link for downloading Tsugaru itself, and the other for the compatibility ROM, which serves as the system's BIOS. Not every title works, but there is certainly enough compatibility to make it worth your time, and getting genuine ROM files to run is otherwise challenging.

For Tsugaru, click the latest "Auto Release" link. Zipped binaries are provided for Windows, Ubuntu, and macOS. Linux users who don't have an Ubuntu-based system can try compiling from source. Download the latest binary release and extract the ZIP file in a new folder. For the BIOS, just click the link and save the ZIP file. Extract the ZIP file somewhere you can find it later.

Windows users can start the program by opening "Tsugaru_GUI.exe." Linux users can either click "Tsugaru_GUI" or, if that doesn't work, open a terminal in the Tsugaru folder and enter:

```
$ ./Tsugaru_GUI
```

Usage

To get started, you have to point to your BIOS files, pick a software image file, choose a control scheme, then start Tsugaru's virtual machine.

To choose your BIOS, under the "Main" tab, click the "ROM dir:" button. Now select one of the files from your BIOS folder to choose that directory.

To choose your software title, click the "CD Image:" button and choose the file for your CD-ROM image. We're assuming the software you want to run is on CD, but if your software is on floppy, click "FD0:" and choose your floppy image.

Before you start the emulation, it's worth defining your controls. If you don't have a joystick installed, click the "GamePort" tab, and from the "Game Port 0:" drop-down menu, choose "Emulation by Keyboard (Arrow and ASZX)." Click "START" and, with any luck, your game should load.

If your controller's fire buttons work but you can't move anywhere in game, under the "GamePort" tab, for "Game Port 0:" try choosing "GamePad0 (Analog Axes as Direction)," which re-assigns movement to a controller's analog stick.

If games refuse to boot at all, it's probably due to the compatibility ROM, but before giving up, try disabling any joysticks, and setting "Game Port 0:" to "Mouse" or another combination of mouse and joystick. Also, some games require a boot disk floppy, so check your ROM source for a list of companion boot floppy images. ■

Find software

Normally, this section is difficult to compile, but not this time. Just go to Archive.org. There are a few other sources here and there, but **Archive.org** has the most extensive collection. There are even freeware compilations, which are well worth exploring, so that's software that we can legally recommend.

Search for "redump.fm.revival" and you'll be taken straight there.

As for language barriers, if you don't fancy guessing your way through a bunch of in-game Japanese text, try sticking to major arcade conversions and famous DOS ports.

Viewpoint (1993) is a fresh and innovative take on scrolling shooters and a personal favourite of ours.

© wikimedia/Picopon, Sammy

GAMING NEWS

Valve announces powerful handheld Steam Deck

It's like a Nintendo Switch, but open, and it can play your Steam library.

Valve announced the Steam Deck in July, a handheld gaming console that will run Valve's Linux-based SteamOS out of the box. The impressively spec'd handheld comes in three models and will be capable of playing the vast majority of games in your Steam library, thanks to the Proton compatibility layer that helps Windows software play nice with Linux.

The Steam Deck boasts an AMD Zen 2 CPU, an AMD RDNA 2 GPU with 1-1.6Hz clock speed and 16GB LPDDR5 RAM. The 7-inch LCD touchscreen will run games at a native 800p with a refresh rate of 60Hz. You'll be able to use most peripherals with it, thanks to Bluetooth and USB C connectivity, and it also has DisplayPort 1.4 support. With a Nintendo Switch style dock available separately, you can basically use the Steam Deck as a desktop PC, if you want. Valve has described the console as an "AMD powerhouse" and apparently you'll be able to run modern blockbuster games on it: Valve has already shown Remedy's 2020 action game Control running on it. If you want to tear SteamOS off the Deck and install Windows, you can, and Valve has already itself stated that you can buy games from other PC storefronts (ie, the Epic Games Store) if you want.

ABOVE: Will Steam Deck succeed as a new PC platform?

What's the catch? It's only shipping to the US, Canada, UK and European Union at the moment, with more regions set to roll out in 2022. Stock seems all but depleted at the moment, with reservations quickly drying up and eBay now flooded with the nowadays customary scalpers. Given that the 2019 Valve Index VR kit was only made available in Australia in August, we may be waiting a while.

In the US, prices start at $399 for the 64GB model, which uses an eMMC drive. Both the 256GB model ($529) and the 512GB model ($649) come bearing a superior NVMe SSD.

Red Dead Redemption 2 gets DLSS

NVIDIA PROMISES PERFORMANCE BOOSTS OF UP TO 45 PERCENT.

Red Dead Redemption 2's DLSS update has landed, and according to Nvidia you can expect remarkable performance improvements across the board with RTX cards. Nvidia writes that "all GeForce RTX gamers" can expect over 60 fps at 1080p with settings amped up to ultra.

At 1440p with an RTX 3060 Ti at ultra you should get over 60 fps, while at 4k with an RTX 3070 (or faster) you'll achieve 60 fps with ultra settings. Once the patch has installed, you'll find the DLSS toggle in the Settings / Graphics menu.

Red Dead Redemption 2 released for PC in 2019 but it still puts even the new 30 series cards through their paces, with a fair bit of fiddling required between resolution, detail and framerate. With the DLSS patch, some of those compromises hopefully won't be necessary anymore – and it's especially good news for people still rocking 20 series cards.

Xbox Series S clip-on screen basically turns it into a gaming laptop

All you'll need is a power outlet to play Xbox Series S with the xScreen.

Turn your Xbox Series S into a laptop-like machine with this attachable screen, which launched on Kickstarter yesterday and reached its funding goal in just 20 minutes.

The Xbox Series S xScreen is a clip-on screen that'll let you play your Xbox Series S anywhere there's a power outlet. That way, when the Series S' jerk big brother Xbox Series X is hogging the main TV, you can simply attach the xScreen to your Xbox Series S and game to your heart's content.

The 11.6-inch 1080p IPS screen has a pair of built-in stereo speakers, controls for things like volume and brightness, and a more than serviceable 60Hz refresh rate. The screen is sized such that it folds into the Xbox Series S for a flush fit – UPspec says the screen and console connected can fit inside a 15-inch laptop bag.

The xScreen connects directly to the Xbox Series S' HDMI and USB ports and is designed so that the existing power and storage expansion slots are still easily accessible with the screen attached. Though the peripheral screen doesn't need its own power supply, the console itself will still need to be plugged into a power outlet.

AMD's FidelityFX Super Resolution rolls out for Unity and Unreal

THE UPSCALING TECHNOLOGY SHOULD GIVE NVIDIA'S DLSS A RUN FOR ITS MONEY.

AMD has rolled out support for its FidelityFX Super Resolution to both the Unity and Unreal Engines, meaning developers working with those popular game engines can start to implement the spatial upscaling tech in their titles. The tools are available in beta for Unity users, and to all registered Unreal Engine developers.

In addition to those broader engine rollouts, patches have also released for games including *Resident Evil Village, Necromunda: Hired Gun, Arcadegeddon* and *Edge of Eternity*. *Arcadegeddon* is an interesting case, as it may be the first evidence of FSR coming to PS5: the shooter is a PS5 console exclusive (that's also coming to PC). Microsoft has already confirmed that FSR will come to Xbox.

Scientists have developed a video game that can help towards cancer research

A science-based video game is looking for players to help train its algorithm so that it can detect cancerous cells from just an image.

AcCELLerate, as the game is known, requires players to trace over photos of dye-stained tongues using a smartphone or mouse, which isn't as gross as it sounds. These fluorescent coloured scans become more difficult to trace as the game progresses and with enough results, will go towards real scientific research into oral cancer.

By repeating this process, players will effectively be training an algorithm to detect certain patterns in medical images so it can eventually go on to pick out potential cancerous cells from a scan quicker than a scientist could by eye. The game was developed in collaboration with King's College London Centre for Stem Cells and Regenerative Medicine and data founded by Dr. Priyanka Bhosale.

World of Warcraft: Wrath of the Lich King is getting a *Pandemic* board game

A board game crossover between *World of Warcraft* and the *Pandemic* series has been teased via a short YouTube trailer. Themed after the *Wrath of the Lich King* DLC, this mashup is due for launch later in 2021, Spring to be precise. The game's playable characters appear to be *WoW* mainstays Sylvanas, Thrall, and Varian Wrynn

Dark Souls 3 gets a 60FPS performance patch on Xbox Series X and S

Dark Souls 3 will be getting an update on the Xbox Series X and Xbox Series S versions. This update, as Xbox revealed, will boost the game's frame rate up to 60FPS, making it the next in a long line of games to have received an FPS boost performance patch on Xbox's next-gen consoles. ■

apc RECOMMENDS

$ 28 | PC, PS4, Switch, Mac, Linux, XB1 | klei.com/games/griftlands

Griftlands

Play your cards right and this will tell you a great story.

Game designers have always been looking for ways to make conversations as compelling as the combat. Why can't a tense negotiation feel as gripping as a tough-as-nails boss fight? That's the question *Griftlands* seeks to answer. It makes for a compelling roguelike, thanks to great writing and characters, but doesn't quite live up to the promise of its chatty deck-building systems

The titular *Griftlands* consist of chaotic, almost post-apocalyptic sci-fi settlements ruled by corrupt cops and criminal syndicates. Brutal it may be, but it sure is pretty. There's a smart economy to where the embellishments are made to ensure that the game can deliver on its scope without any rough edges. Character sprites get lovely gestures and expressions that complement the writing while the overworld map is littered with icons.

Its factions are written in broad caricature, in line with the game's cartoonish nature, but paint a good picture of the world you step into life as a 'grifter', the game's shorthand for smooth talking mercenary. There are three characters to play as (each with their own story) but only one is unlocked to start with – Sal, a once indentured slave now on the hunt for the woman who sold her.

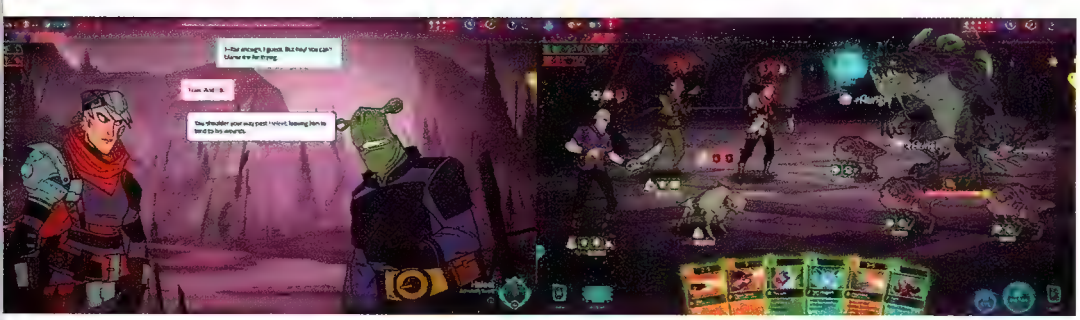
What a relief it is to play an RPG that doesn't involve scrolling through paragraph after paragraph about some guff that happened a thousand years ago. There's an immediacy to everything in *Griftlands*, whether its the world-building or the stakes: life's short, it's only what's in front of you that really matters.

The writing itself is engaging and even the smallest of characters get a chance to make an impression, all the more as you collect a small arsenal of subplots en route to your over-arching goal. For me, the allure of its story was far greater than its expanding deck building.

There are two modes of play: Battles and Negotiations. Both are turn-based and use cards. In battles, your deck is full of attacks, blocks, and powers – largely fun, but fairly conventional. The negotiations are rather more interesting. For those you draw from an entirely different deck, and your cards are used for building 'arguments' against your opponent. You're constantly striving for a deft balance of chipping away at your foe's lesser ideas while piling plenty of damage onto their core argument. I really felt like I was always juggling a lot of plates in the best way, the pressure always on to make the most of each turn.

Griftlands is another slice of low-key brilliance from developer Klei. Is there a genre they can't do? Balancing narrative and deck building gave me a much more compelling experience than I often have with card based titles, even if it feels like more could be made of those systems to bolster its storytelling.

SAM GREER



Succeeds in overcoming the limits of its deck-building with charm and good storytelling.

★★★★☆

$35 | PC, PS4, Linux, Switch | roguebook.net

Roguebook

This deckbuilding dungeon crawl stands out, but avoids greatness.

Those who've found their gaming niche in deckbuilding roguelikes have something to be happy for in *Roguebook*, a confident, competent release from Abrakam Entertainment, the creators of *Faeria*. Set in the same world, it's a colourful, whimsical and charming fantasy. It also very proudly fits the genre mould: run-based gameplay that unlocks new cards, treasures, and characters for increasingly powerful builds to take on challenges.

To its credit, and to its detriment, nothing in Roguebook is particularly novel. Its familiar parts are arranged in a new way with a few twists. Your deck is a combination of two out of the four characters, each with their own unique cards and talents – you gain access to talents as your deck grows. With your two heroes you move into the book's blank pages, represented with a hex grid, and explore by spending brushes and ink to reveal the painted landscape. You find gold to use at the shop, new cards, adventure events with weird consequences, and fights to flex your deck.

Fights are straightforward attack card versus block card brawls with a few twists. Your two heroes have positions, leading and following, and cards often swap them around. Moving characters is a big tactical decision: enemies always attack the leading character, while certain cards can only be used from certain positions. You can also summon allies, who are like battlefield effects that wear down opponents or give you a limited-use ability. The reward for winning a fight always includes more ink, for a limited reveal, or a new brush for a big one. When you run out it's time to fight the level boss, and at the end of the third level you fight a big boss to win the run.

The mechanics largely work, and when they're running smooth they're a joy. But games like this have to rely on being tightly designed or else provide so much fun content that you won't care otherwise. *Roguebook* doesn't quite hit either.

JON BOLDING

Stands out from the pack on a few qualities, but unfortunately it's not a must-play game.

★★★★☆

Free | PC | bit.ly/pocketwonder

Pocket Wonder Sport

Reaching into a grab-bag of weird minigames.

This ten-game collection takes you from undead hockey matches through to duelling toy grabbers and perilous acts of architecture. While some of the concepts might seem ludicrous, they've resulted in several novel minigames.

I'll tell you about some of the highlights. The wonderfully named *Dead Ice* plays like a refresh of *Pong*, only with slightly more cumbersome controls and, oh yeah, a steady stream of shambling zombies, which you whack into bits using your hockey stick.

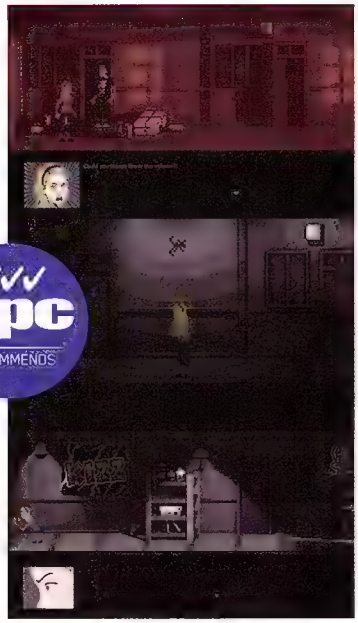
Pool Block, meanwhile, mixes *Breakout* with lane swimming, and it's a clever twist on the arcade block-busting game. Here the paddle takes the form of a horizontal swimmer, while you generate extra balls by doing lengths of the pool.

It's smart, but, like the rest of games, it's missing something: there's no scoring system to record your best runs.High scores, and multiplayer, would make these games come alive, giving you more motivation to replay them, and to keep playing the ones that repeat endlessly. Games like *Pac-Man-meets-gardening game*, *Mighty Mower*, which almost feels like a cult NES game.

TOM SYKES ■

Relive the days of lucky-dip game collections with this bundle of good games based on silly ideas.

★★★★☆



Free | Browser | broelbrak.itch.io

Next Door

Good neighbours become good monsters.

Playing as a woman trying to study in her apartment one night, you're disturbed by the constant sound of loud music coming from the neighbour above. After setting out to confront the man, he deflects your attention to the apartment next to his, where he has seen strange figures coming and going, but where no one seems to be in when you knock on the door. Over the next ten minutes or so, *Next Door* will tell you about those mysterious people. There are some great moments packed into such a compact game.

While the soundtrack is great, it's the artwork that does the heavy lifting here. Specifically, the animation frames of a creature, which moves in unsettling ways.

I'm being vague, but I don't want to ruin *Next Door* for you. It's short, but well-paced, and you can play it in your browser. There are no definitive answers for what's going on in that apartment, and the game is all the better for it.

TOM SYKES

Creates unsettling imagery that will linger in your mind for some time.

★★★★☆

$30 | PC, Mac, iOS, Switch | bit.ly/3h9KGyA

Lego Builder's Journey

Captures the joy of those little plastic bricks.

Lego has been incorporated into dozens of games since the mid-1990s, but none of them bring the magic to life like *Lego Builder's Journey*.

Each of the dioramas that make up *Lego Builder's Journey* is shaped by a single goal – to bring your character from one side of the level to the other. There is, however, no prescribed solution to any puzzle. In true Lego style, you're free to use the blocks provided any way you like. It's often an iterative process, but one with no fail states or wrong answers. Your solution needn't be elegant or efficient. If the pieces fit together, there will be some kind of way forward.

The pieces themselves handle in a way almost as satisfying as the real thing, snapping into place or rattling against each other as you comb through them. It's an amazingly tactile experience, bolstered by the incredible detail on offer in each diorama, all of which are created entirely from actual pieces. Even the story, a simple narrative of parental responsibility and childish imagination, speaks to what Lego has always attempted to invoke.

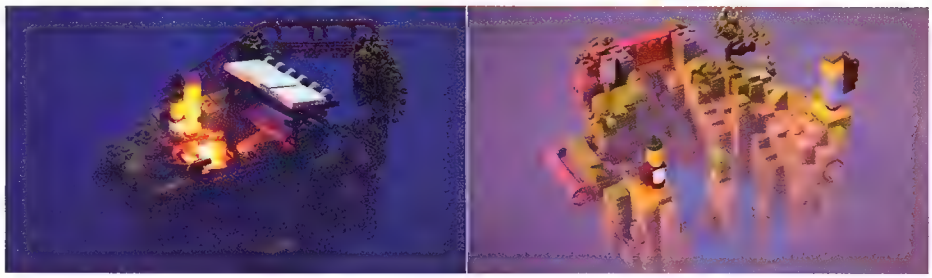
A healthy dose of slapstick and childish naivety ensures *Lego Builder's Journey* never deviates too far from its toybox origins, but the dark, industrial nature of later levels means that its more serious ideas land. While other Lego games lean on the bombast of massive crossovers, this game focuses on what it's actually like to play with those little coloured blocks. It's a subtle approach, but one that obfuscates the game's limited scope, capturing everything from the imaginative freedom that Lego offers to the feeling of handling each individual brick.

Within the beautiful environments and open-ended approach to puzzle solving, this is perhaps the most authentic, earnest Lego game there's ever been. From the sense of freedom that a pile of bricks offers right down to the individual bricks between your fingers, it manages to recreate not just what Lego is, but what it can be.

ALISTAIR JONES

Proves that while not everything is awesome, some stuff is quite good.

★★★½☆



$69 | PC, PS4/5, XB1/S/X | sniperghostwarrior contracts2.com

Sniper: Ghost Warrior: Contracts 2

Infiltrate bases and turn skulls into jelly.

You're Raven, a killer-for-hire dispatched to the Middle Eastern state of Kuamar to prevent a war. Your target is Bibi Rashida, Kuamar's de-facto head-of-state after her husband was assassinated. Rashida's military response threatens to destabilise the regions and cripple Western economies.

Your efforts to dismantle Rashida's regime is spread across five missions so big they're referred to in-game as 'Regions'. These vast expanses of terrain include multiple objectives and various paths between them. Some locations you visit, such as a giant medieval castle that has both an inner and outer fort, would form the entire level of any other game.

Contracts 2's missions are divided into two categories. 'Classic' contracts are familiar infiltration affairs, where you use a combination of sniping and stealth to sneak into locations to assassinate targets and sabotage equipment. But newly introduced to *Contracts 2* are 'Long Shot' contracts. These involve slipping through guard patrols to reach designated Overlook positions, lofty perches from which you snipe at targets over a mile away.

Each long-shot objective is an elaborate sniping puzzle where you use your sharpshooting skills to manipulate both enemies and the environment. The puzzle-like structure of these missions elevates *Contracts 2* beyond a simple head-popping simulator. *Contracts 2*'s blend of classic and long-shot missions helps fix a problem *Ghost Warrior* has struggled with for a while. Sniping in and of itself can get repetitive quickly, but physically infiltrating bases is the opposite of how a sniper operates. By combining *Splinter Cell*-like stealth missions with long-range shooting puzzles, *Ghost Warrior* can have its cake and eat it, providing both elaborate sniping challenges and all the dynamism and gadgetry that stealth gaming offers.

The excellent presentation extends to the writing and voice acting. *Contracts 2* isn't an exercise in jingoistic self-aggrandisement like *Call of Duty* has become. Rather, it takes a cold, pragmatic, and darkly satirical view of contract killing and deniable military intervention in the Middle East. The maps are fantastic and the sniping is great. A perfectly enjoyable stealth sandbox.
RICK LANE

Blending classic stealth mechanics with puzzle-y sniping.
★★★★☆

Free | PC, Mac, Linux | whalesandgames.itch.io

Townseek

A chill, cheery trading game.

Townseek is a trading game, in that you'll need to trade goods to unlock everything, ferrying food and knick-knacks and odds and ends between settlements. Probably the main way it differs from games like *X4* and *Port Royale* is that you're flying a shark-shaped airship, while the towns you find are populated by talking animals.

Not just animals, but friendly henge-people too, hailing from the town of Stonehengeopolis, which offers decent deals on sketchbooks and 'jazzy tunes'. *Townseek* is set in a sweet, almost twee post-apocalypse, which you explore by flying your blimp across its shrunk-down version of Earth. In addition to the trading element, it's also partly a walking, er, floating sim, as there's no particular goal beyond exploring for exploring's sake. You'll encounter things like a 'drooling volcano' and a 'polite whale' as you scour the world. The art is cute, although the narrative bits are insubstantial. I enjoyed discovering the things that were available for trade, and then fleshing out my journal.
TOM SYKES ■

A laid-back trading game that just wants you to hang out in its cosy world.
★★★½☆

Before Io was covered in skyscrapers and smoke (and fungus).

DEVELOPER UBISOFT **PUBLISHER** IN-HOUSE **RELEASED** 1997 **WEB** bit.ly/3wOZucj

POD: Planet of Death

Ubisoft's racer faces a second apocalypse. By James Davenport

Created as a graphical showcase, *POD* was an elaborate tech demo, a grim science fiction racing game that came baked in with a lot of computers using Intel Pentium or Pentium II MMX processors, and some AMD K6 systems. Back in 1997, it was one of the best looking games you could play.

If you grew up in the 90s and knew anyone into PC gaming, it was probably on their computer at some point. *POD* was one of those cultural artefacts that huge swaths of the public were involuntarily introduced to, like when They Might Be Giants' song *Older* came packed in with RealPlayer on so many early 00s HP prebuilts, or Chip's Challenge in a Windows 3.1 entertainment bundle. Ubisoft later released a retail version, but *POD* was birthed from the same tradition as Norton Antivirus and Mcafee: OEM software, baby.

Following one of the most essential PC gaming myth arcs, my uncle had a gaming PC in his basement, nested in one of those huge faux-mahogany desks that shouldn't have been able to fit through the door. The CRT was too big for its available surface area and audibly hummed for about two minutes after it was powered off, the keyboard stuffed into a wide drawer not meant for keyboards resting on a soldier's stew of thumbtacks, erasers, pencils, and pennies. A very domestic strain of cosmic horror.

But the dust illuminated by a tiny window (a fire code violation for sure) only elevated *POD*'s grimy, nihilistic excuse for racing. I almost felt like a two-faced booker, watching the races from some remote warehouse location. The only thing missing was a cigar and a frosty mug of spoog or grumm, or whatever future wasteland beer alternative existed in *POD*'s universe. The whole thing foretold my obsession with Thumper, because *POD* was the first time I remember playing a game purely for the bad vibes.

Fun guys

It's the distant future on a planet very creatively named Io. Humanity builds a bunch of weird, bulky skyscrapers as fast as possible, eventually covering what looks like the entire surface area of the planet, all in the name of job creation. A capitalist critique is incoming, but no, humanity isn't its own undoing. This is a story about nature getting its revenge. And yes, it's a racing game, too, I promise.

A super fungus creeps out of the planet's surface and feasts on all those wacky skyscrapers – and mankind too, for dessert. People dip out on ships in droves until there's just one space taxi left. Naturally, every remaining human alive calmly agrees to conceptualise, plan, and enact an elaborate mid-apocalypse racing circuit for the final seat. The whole story is laid out in this elaborate, four-minute intro cutscene, where the music moves from synthy sci-fi to electric

LEFT: Driving through the sewers, as you do. **BELOW:** We need to be more creative with road design. **RIGHT:** Like driving down the alien's spine.

guitar power ballad. We go to space, see civilisations rise and fall, and cars shaped like bird feet crash into skyscrapers. At the time, it blew my head off. Today, it's incredibly dumb, but so are my sensibilities. God, I love *POD*.

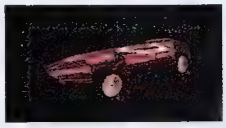
Well, I love *POD* as I remember *POD*. I remember the most beautiful palette of greys and browns and greens and oranges streaking together I'd ever seen in a game. Beltane is a sprint down the city freeway, a dour purple sky in contrast with the yellow glow of the last remaining skyscrapers with power. I love the surreal hillsides of Pompeii with its roads stretching out at impossible angles into the distance. Plant 21 is what Bowser's Castle would look like if it was set in an abandoned industrial shipyard, and if Bowser was a 50-year-old mob boss, I suppose. Then there's Roc, which imagines the art of HR Giger as a river, a psychosexual racetrack of spires and jet black organic-seeming pipes and machinery forming hypnotic, pulsing patterns on every surface. If you've ever wanted a track to make you horny and sad, *POD*'s got you. There's so much more to see, too. With over 30 tracks in the final version, it's worth at least checking out the sights in each.

I remember cars that felt heavy and powerful, and that every impact with another vehicle resounded with a deep impact that sold the fantasy of driving a future tank cobbled together with slabs of rusted, corrugated metal and gas line pipes refitted for the express purpose of going fast. I remember an overwhelming sense of menace and dread from the odd scenery running beside every track, and how the sharp angles of every car spoke to some alien knowledge of aerodynamics and technology. My mum's 97 Astro van looked even more like a cinder block in comparison – though, to be fair, it was very grey and very rectangular.

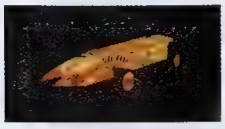
POD was one of the first pieces of media to make me truly consider the end times, and it was all filtered through The Rule of Cool. Ubisoft made an unnerving, sickly thing for my simple eight-year-old mind, whose only other conceptual playdates with the end of civilisation were limited to the dirt towns I made for the ants in the

CAR-APACES
POD's weird cars remind me of stuff

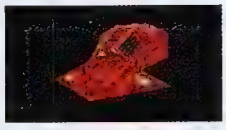
BAKAR
A salamander with knobby limbs.



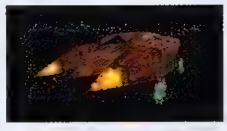
GAMMA
That's a Hershey's bar, that is.



DOPPLE
A car fresh out of the wood chipper.

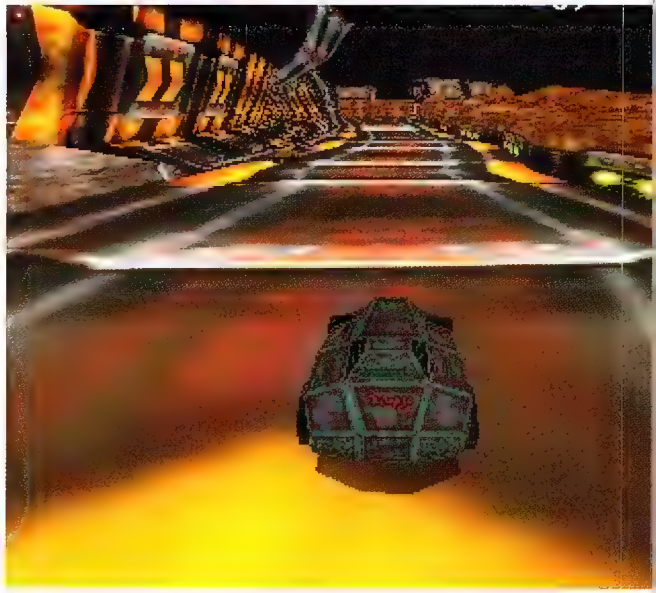


SHIVAN
I'm getting salamander again.



SCORP
POD's infamous chicken foot.

RIGHT: The UI is pretty, but the stats don't matter much.
BELOW: Nice weather, eh?



backyard. Even so, I couldn't look away. I didn't want to.

The truth is that, even though *POD* is easy to find and run through an updated version on **GOG.com**, it has aged far worse than I expected. If you play it anyway, find the *POD* entry on **PCGamingWiki.com** and install the PodHacks patch for some bug fixes and more flexibility with the forced 800 x 600 resolution, which can cause some issues on dual-screen setups. There's a widescreen hack too, though it breaks some of the skyboxes which I'd argue are The Point of *POD*. If you're one of these smug post-gamers like myself, maybe you can appreciate the game falling apart in front of your eyes. I do, but I don't go around telling people about it. Can you imagine being that insecure?

Pod racing

My hands are too big for the simple arrow-key controls, and cramped up after just a few races. Handling is awful too, with cars accelerating wildly from short taps of the keys. A seemingly deep stat system allows you to reallocate 300 points wherever you like, into braking, acceleration, turning, and the like, though it doesn't add up to much in action. *POD* has a fixed meta, favouring speed and turning, so long as you've got the requisite track knowledge. You either get to know the tracks like the alleys of your hometown, or die.

POD plays into early racing game design, where success was primarily based on extremely granular muscle memory, both in track memorisation and turn acceleration. Staying on the course is the primary challenge. Avoiding the walls is the fun. Game design really has come a very long way since *POD*'s days.

But *POD* is so, so touchy and the tracks so narrow and crowded that you spend a lot of time bouncing off the railings and other cars. I'm reminded of *F-Zero*, the way you can get into a flow state of perfect key presses and depresses once you've built up enough familiarity with a track, but without the same sense of speed and far more abruptly windy, punishing turns. And if you have *POD*'s damage system turned on, getting through a single race is a monumental, frustrating challenge.

I respect the implementation of a damage system, especially to sell the

LAP TWO Better racing games to revisit

LEGO RACERS
Build your own custom car brick by brick, and use it to travel across time and space.

STAR WARS EPISODE I: RACER
Nice and fast, and you can turn sideways!

SONIC & ALL-STARS RACING TRANSFORMED
You can play as *TF2*'s Heavy.

BURNOUT PARADISE
Nothing faster and more indulgent, and the soundtrack's ace.

Love the unexplained white void.

fiction that these are shitty, rusted carapaces barely holding together – but the cars break down faster than I do looking at myself in the mirror. The landscape of my brain just isn't built for this kind of skeletal trial and error anymore. I am old now and have important stuff to do, like compulsively checking my phone and worrying for no reason.

One of these clips in my mind: murky brown skyscrapers on the horizon, a skybox like vomit, and my wheels sailing through the air over the main track below. I found a shortcut for the very first time in a racing game. I remember recognising them in later racing games, like *Star Wars Episode I: Racer*, where you had to not only make sharp, quick turns but flip your racer horizontally to squeeze through a tiny crevasse; or in Lego Racers, where an early track on an alien planet opens up a shortcut based on secret sequence of coloured gates you drive through.

Maybe *Lego Racer*'s puzzle-solving and *Episode I: Racer*'s needle-threading ruined me. *POD*'s shortcuts are boring and bad, 90-degree turns into tighter hallways with the occasional ramp as a treat that barely saves time. I'm grateful to *POD* for teaching me to pay attention, but in retrospect I feel a little cheated. Time is mean, man.

POD is preserved so well in my memories because of its simple premise, and for how evocative its courses and cars are of a world with an accelerated history in ruin, all without ever explicitly detailing the goings-on of the world. It might've been my first ever apocalyptic setting, and more than anything I remember the mood *POD* put me in.

Tune in

Music was a major component, with a soundtrack put together by Daniel Masson of *Rayman 2* fame. The score isn't very long, but it works on repeat. As you race, the same looping 15 minutes of trance play out, a steady journey from sparse celestial arrangements to more percussive industrial movements that wouldn't sound out of place in the original *Half-Life*. If you do play, I recommend turning down the SFX and juicing the music. Get rid of the other racers too and *POD* basically transforms into poor man's *Thumper*. Even though it's lacking the syncopation, it's a more immediately hypnotic way to play, at least before the arrow-key cramps ruin your hand for the day. If that's too much, the 15-minute MP3 is right there for the taking in the *POD* game directory. Add that to your favourite playlist in WinAmp, throw on a good visualiser, do some future post-apocalyptic sci-fi drugs that don't exist, and shake out those cramps.

This might be the first Reinstall where I've actively ruined a game for myself, where I've written over strong childhood memories with the sad impatience only 31 years of adequately comfortable living can produce. But like the ending cutscene of *POD* – in which you barely escape the planet before it's completely enveloped in fungus and ride away on the final ship as Io blossoms, the literal crust of an entire planet splitting and flowering, farting out globules of pollen into the cosmos – it's OK to move on. Something else will take its place, like a huge space flower, or more voracious evil colonisers, or *Mario Kart: Double Dash* or whatever. I don't know anymore. ■

CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS

Illegal crypto mining operation run on PS4s

Ukranian crypto farm uses consoles to mine rare game characters.

In attempting to try and find the culprit siphoning off enough power to cause whole neighbourhoods in the Ukrainian city of Vinnytsia to lose power, local police stumbled on a large mining facility that was running entirely on PlayStation 4s. The operation behind the 3,800 daisy-chained game consoles is accused of stealing US$256,648 worth of electricity from the Vinnytsiaoblenergo energy distribution company by using modified energy meters. But they weren't mining crypto, as one would expect, instead it appears the PS4 operation was mining *FIFA 2021* players and in-game currency. Officials from the power company (located next door to the mining operation) have not been disqualified as suspects yet.

Apple's disabled its weather app from displaying the number 69

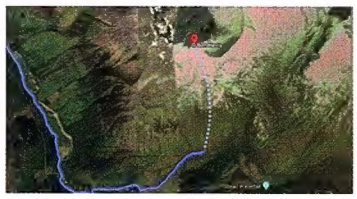
The common temperature is far too rude to mention according to iOS.

69 degrees Fahrenheit is roughly 20.5 degrees Celsius, so it's a pretty common ambient temperature in most parts of the US. It seems however that the number, which is commonly understood to be an innuendo for a sexual position, has just been expunged from Apple's numerical vocabulary in order to not offend any user's sensibilities. The issue seemed to only be present on iOS 14.6, so we don't expect it to become like the 13th floor of buildings. It's also possible that the app is converting to Fahrenheit from Celcius and rounding to the nearest degree.

AI trolls politicians spending parliamentary time on their phones

THIS AI CRACKS THE WHIP ON POLITICIANS SLACKING ON TAXPAYER'S TIME.

Flemish digital artist Dries Depoorter created an AI-driven system that analyses Belgian parliamentary footage for politicians looking at their smartphones while 'listening' to arguments made prior to legislation voting. The stunt was inspired following a public outcry when Flemish Minister-President Jan Jambon was caught playing *Angry Birds* during a policy discussion a couple of years ago. The AI sifts through the YouTube broadcasted parliamentary proceedings each day and if it detects distracted politicians it uploads a clip to @TheFlemishScrollers Instagram page and links to the politician's handle with the message "Dear distracted XX, pls stay focused!"



Google Maps offering deadly hiking routes to novice walkers

MOUNTAINEERING GROUPS WARN OF LETHAL GUIDANCE BY POPULAR NAVIGATION APPS.

Google is a pretty reliable tool when it comes to navigating cities, but its maps extend to almost every area of the globe and mountaineering groups in Scotland are warning that the navigation tool is leading people up 'potentially deadly' hiking routes. Nathan Bernie, a Conservation Officer for Ben Nevis, the highest mountain in the British Isles, has lodged concerns with the Silicon Valley company over a number of suggested paths to the 1,345 meter summit that are "highly dangerous, even for experienced climbers." After reviewing the suggested route a spokesperson for Mountaineering Scotland went further suggesting the route Google suggested was "potentially fatal". ■

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